AD-A076 922 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5
AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MED--ETC(U)
SEP 79 V R GILLOTH , J F OHL, W A WELLS

UNCLASSIFIED AFIT-LSSR-13-79B NL

1 OF 3
AD-
A076922

AD A076922

LEVEL II

AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MEDICAL MATERIEL MANAGEMENT SYSTEM

Vaden R. Gilloth, Captain, USAF
Jack F. Ohl, Jr., Captain, USAF
William A. Wells, Lieutenant, USN

LSSR 13-79B

DDC FILE COPY

DDC
RECEIVED
NOV 20 1979
A

UNITED STATES AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
Wright-Patterson Air Force Base, Ohio

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

79 19 9 057

AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MEDICAL MATERIEL MANAGEMENT SYSTEM

Vaden R. Gilloth, Captain, USAF
Jack F. Ohl, Jr., Captain, USAF
William A. Wells, Lieutenant, USN

LSSR 13-79B

DDC
RECEIVED
NOV 20 1979
A

DISTRIBUTION STATEMENT A
Approved for public release
Distribution Unlimited

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information are contained therein. Furthermore, the views expressed in the document are those of the author(s) and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the Air Training Command, the United States Air Force, or the Department of Defense.

USAF SCN 75-20B AFIT Control Number 13-798

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/ LSH (Thesis Feedback), Wright-Patterson AFB, Ohio 45433.

1. Did this research contribute to a current Air Force project?

   a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Can you estimate what this research would have cost if it had been accomplished under contract or if it had been done in-house in terms of manpower and/or dollars?

   a. Man-years _____ $ _____ (Contract).

   b. Man-years _____ $ _____ (In-house).

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

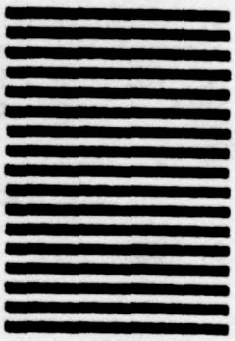
5. Comments:

Name and Grade _____ Position _____

Organization _____ Location _____

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES



BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 73236 WASHINGTON D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

AFIT/LSH (Thesis Feedback)
Wright-Patterson AFB OH 45433

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: LSSR 13-79B
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MEDICAL MATERIEL MANAGEMENT SYSTEM.

5. TYPE OF REPORT & PERIOD COVERED: Master's Thesis
6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s):
Vaden R. Gilloth, Captain, USAF
Jack F. Ohl, Jr., Captain, USAF
William A. Wells, Lieutenant, USN

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
School of Systems and Logistics
Air Force Institute of Technology, WPAFB OH

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS:
Department of Communications and Humanities
AFIT/LSH, WPAFB OH 45437

12. REPORT DATE: Sept[illegible]79
13. NUMBER OF PAGES: 243

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)
257

15. SECURITY CLASS. (of this report): UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

AFIT-LSSR-13-79B

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

JOSEPH P. HIPPS, Major, USAF
Director of Information

1 OCT 1979

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Seasonality
Medical Inventories
Double Exponential Smoothing
Moving Average Forecasting
Adaptive Response Rate Forecasting

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Thesis Chairman: Captain Darrell N. Fulton

012 250

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Providing optimal logistical support to Air Force medical facilities is the main objective of the United States Air Force Medical Materiel Management System (MMMS). The inventory management and control procedures contained within this system have adequately met customer demands; however, the Surgeon General's Office feels that the same level of customer service could be achieved with a lower inventory investment. Previous studies on the MMMS have indicated that seasonal variation may be a significant contributing factor to the high cost of medical inventories. This research analyzed the existing computerized data to identify the extent of seasonality. The results of this analysis demonstrated that seasonality is significant, identifiable, and forecastable. Using the current forecasting method as the base, two additional techniques were tested for their ability to adjust for seasonality. Double Exponential Smoothing was demonstrated to be superior to the currently used Moving Average method.

LSSR 13-79B

AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MEDICAL MATERIEL MANAGEMENT SYSTEM

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degrees of Master of Science in Logistics Management

By

Vaden R. Gilloth, BS
Captain, USAF

Jack F. Ohl, Jr., BS
Captain, USAF

William A. Wells, BE
Lieutenant, USN

September 1979

Approved for public release;
distribution unlimited

Accession For
NTIS GRA&I
DDC TAB
Unannounced
Justification
By
Distribution/
Availability Codes
Dist. | Avail and/or special
A

This thesis, written by

Captain Vaden R. Gilloth

Captain Jack F. Ohl, Jr.

and

Lieutenant William A. Wells

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degrees of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(ACQUISITION LOGISTICS MANAGEMENT MAJOR)
(Captain Vaden R. Gilloth)

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(Captain Jack F. Ohl, Jr.)
(Lieutenant William A. Wells)

DATE: 7 September 1979

Darrell N. Fulton
COMMITTEE CHAIRMAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

Statement of the Problem

The main objective of the present United States Air Force Medical Materiel Management System (MMMS) is to provide optimal logistical support to Air Force medical facilities as prescribed by Air Force Manual 67-1, Volume V. The inventory control procedures outlined in this manual require a minimum of 95 percent fill-rate on customer demands, while maintaining an economical level of inventory (21:p.1-1). The United States Air Force (USAF) Surgeon General's Office believes customer requirements are being satisfied; however, key staff personnel have stated that the same level of customer service could be achieved with a lower inventory investment (7). Although AF Manual 67-1 establishes a firm guide for what is considered economical, the Surgeon General's Office and the Air Force Data Systems Design Center suggest that fluctuations in demand, possibly caused by seasonal variation, could be a significant contributing factor to the high cost of inventories. The problem for research is to identify these seasonal variations and their effect on the medical inventory system.

Justification

The Department of Defense has recognized that within the logistics support system certain commodities possess

pecularities or characteristics that make them sufficiently distinctive to warrant separate management (20:11). The unique nature of medical supplies warrant this separate management. The critical features of rapid responsiveness, shelf life limitations, and climate control are characteristics of medical inventories. Many drug items require close monitoring to insure that their shelf life and temperature ranges are not exceeded. "In the medical sector, there are few inventories maintained that are not subject to expiration dates and perishable controls [13:735]." For these reasons, medical supplies have been segregated from nonmedical supplies and are managed under a separate inventory control system, the MMMS (21:p.1-1).

The importance of medical inventories requires that strict considerations be made by the Air Force in handling and managing such inventories. Basically, the management goals are to maintain as low an inventory as possible while still providing the customers a 95 percent fill on all line items demanded. To achieve such a level of service requires a substantial investment in inventory stocks. In fiscal year 1978, the Medical Materiel Management System consisted of 101 Air Force medical supply accounts. These accounts required the management of over 15,000 individual line items, with a total net sales of over $93 million, and an average inventory investment of over $10.5 million. The inventory turnover rate during this period was 8.8 (24). The large dollar values involved in this system suggest substantial potential savings

could be realized with even a small improvement to the inventory system.

Background

The medical materiel inventory system involves many decision parameters. These parameters include such factors as safety levels, pipeline times, economic order quantities, daily demand rates, stock control levels, and seasonal influences. Previous studies in the area of medical materiel management have specifically addressed some of these factors. Peacock and Seale attempted to apply a variable safety level to the system in order to improve the service level (14:6). Ferguson addressed the Daily Demand Rate (DDR) computation and provided a formula for determining a new DDR factor which could ultimately affect the stock control level, the reorder point, and the safety level (8:22). In a related study, Bloss, Moccia, and Rowland designed a computerized inventory control system for the pharmacy at the Medical Center, Wright-Patterson AFB, Ohio (3:1). In all three studies, specific recommendations were made for continued research regarding seasonal effects on the medical supply inventory system. Peacock and Seale stated, "A model could be developed to evaluate the trends and seasonal factors upon the USAF Medical Materiel Management System [14:63]." Ferguson indicated that any development of a new inventory control system should include a seasonal factor. "If properly designed, the seasonal factor should be sensitive to a seasonal demand pattern and

insensitive to other demand patterns [8:18]." Bloss, Moccia, and Rowland also indicated in their research that demand data revealed drug items that appeared to have seasonal fluctuation patterns (3:34). They suggested future study in this area for system improvement. Recent interviews with Captain Larry B. Van Cleave, Staff Officer, Air Force Medical Materiel Field Office (23), Mr. Larry Prior, Systems Analyst, Air Force Data Systems Design Center (15), and Major Graden Casto, Chief, Materiel Management and Procedures, Headquarters United States Air Force Surgeon General's Office (7) strongly confirmed the need for continued research into the seasonal effects on medical inventories.

Objectives

Based on the research efforts previously mentioned and the guidance of those currently working in the Medical Inventory Management System, the specific objectives of this research were:

1. To establish criteria for identifying seasonality in medical materiel inventories.
2. To determine the extent of seasonality.
3. To develop changes to the current computer system to allow for adjustments for seasonality.

Research Questions

The major emphasis for this research was directed toward answering the following questions:

1. To what extent are seasonal variations present in

the medical inventory system?

2. Can seasonal variations be accounted for by modifications of the present computer system?

Chapter II

DEVELOPMENT OF CURRENT SYSTEM

Inventory Theory and Models

According to Turban and Meredith, the major reasons for maintaining an inventory include: protection against irregular demands and irregular supply, protection against inflation, and to allow firms to take advantage of large quantity discounts on orders (18:365-366). The two key problems that usually face any firm when attempting to establish an appropriate level of inventory are when to order, and how much to order (11:475). The amount of inventory on hand depends on the amount of consumption and the length of lead time needed to acquire replenishment of stocks. In a deterministic model, where it is assumed that demand is known and lead time is known, it becomes very easy to determine when an order should be placed and how much should be ordered. An order is placed when the balance will just be adequate to fill demands during the lead time. The order will then arrive at exactly the time that the inventory balance reaches zero. The quantity to be ordered will be the quantity needed to bring the stock up to the predetermined level. An illustration of the deterministic model is represented in Figure 1 (18:225).

In reality, however, managers are not fortunate enough to be able to determine with complete certainty what the demand

and lead time will be. Therefore, managers have developed safety levels designed to absorb variations in normal demands and normal lead times. The amount of the safety level limits to a large extent the number of times that a stock-out* condition will occur. "No institution can afford to carry inventories for all items so large that it can protect itself against every situation [2:59]." Therefore, management must decide what amount of stock-outs is acceptable and set the safety level at a point where they can achieve this goal. This method is based on the probability that demands and lead time will fluctuate within certain limits, which makes this a stochastic model. An illustration of a stochastic model is depicted in Figure 2 (19:225). In this model, whenever the consumption drops on-hand inventory to zero, a stock-out condition exists. Figure 2 illustrates that the reorder point should occur at the time that consumption will cause the balance to fall just to the safety level during the anticipated lead time. The safety stock should be used only when demand or lead time exceeds the normal. The amount to order will always be the amount needed to bring the balance up to the predetermined level. The problems for the manager are to determine the level and at what percentage of that level the reorder point should be established. The MMMS approach to solving these problems has been to use the A-B-C method of inventory control.

---

*Stock-out--A condition when demand cannot be filled from existing stocks.

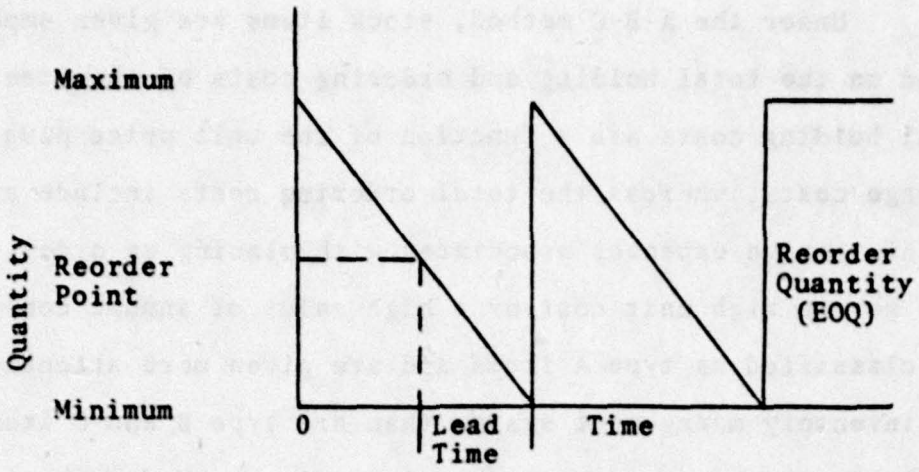


Figure 1. Deterministic Inventory Model

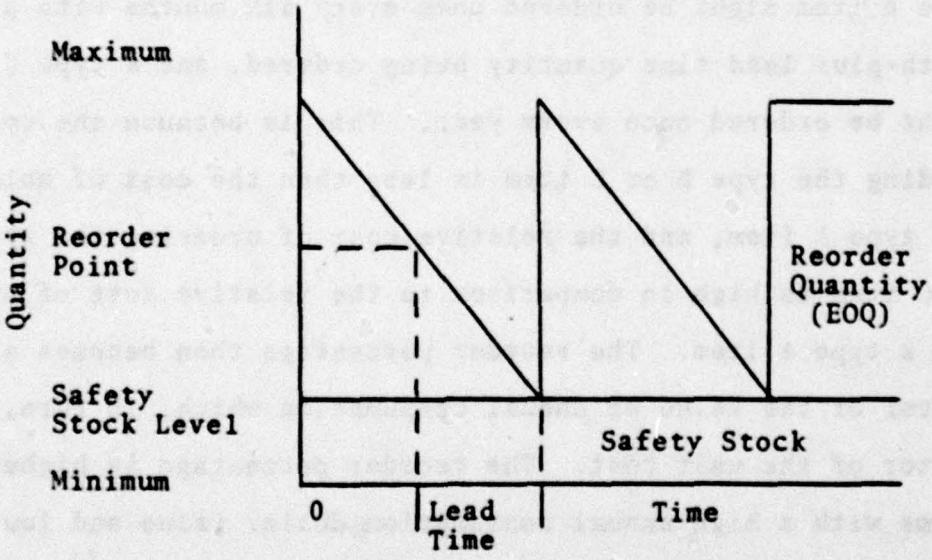


Figure 2. Stochastic Inventory Model

Under the A-B-C method, stock items are given emphasis based on the total holding and ordering costs of the item. Total holding costs are a function of the unit price plus storage costs, whereas the total ordering costs include all administrative expenses associated with placing an order. Items that have a high unit cost or a high value of annual consumption are classified as type A items and are given more attention in the inventory management system than are type B and C items, which have lower cost or consumption values. Under the A-B-C method of control, orders are placed more frequently and in smaller quantities for high dollar value consumption items. For example, a type A item might be ordered once a month with a one-month supply plus lead time being ordered, whereas a type B item might be ordered once every six months with a six-month-plus lead time quantity being ordered, and a type C item might be ordered once every year. This is because the cost of holding the type B or C item is less than the cost of holding the type A item, and the relative cost of ordering the type B or C item is high in comparison to the relative cost of ordering a type A item. The reorder percentage then becomes a factor of the value of annual consumption which, in turn, is a factor of the unit cost. The reorder percentage is higher for items with a high annual consumption dollar value and low for items with low annual consumption dollar value (9:65-67).

The Medical Inventory System

The MMMS operates similar to the stochastic inventory model. The system takes into account the possibility of random

variations in demands and delays in receipt of orders. In order for the system to operate, certain variables must be computed during each processing cycle. The Economic Order Quantity (EOQ), the Safety Stock Level (SSL), the Pipeline Time (PLT), the Daily Demand Rate (DDR), the Stock Control Level (SCL), the Reorder Percentage (ROP), and the Reorder Point (RP) are the variables used to determine the optimal inventory balance within each processing cycle (22:p.8-1 to 8-4). These variables are computed on an individual basis and are used to forecast one month in advance the expected demand for each line item and the appropriate levels associated with that demand. The operating period for computations is one month and the forecast uses as its basis the following parameters.

Moving Average Method. The moving average provides a means for determining the expected demand the following month and is expressed by the following formula:

$$ED_{t+1} = \frac{1}{m} \sum_{i=1}^{m} D_i$$

where:

m = months of history consumption, not to exceed 12 months

ED_{t+1} = expected demands for next period

D_i = actual demand for the ith period (21:p.8-4)

Requirement Code. In the present system, the normal number of days between ordering of replenishment stock is determined by the annual dollar value of issues (22:p.8-3). The annual value of consumption is used to determine the Requirement Code for

each item in inventory. The Requirement Code then specifies the value of certain variables used to compute other parameters. The primary purpose of the Requirement Code is to incorporate the A-B-C inventory method into the system. The Requirement Codes, as specified in AFM 167-240, are shown in Table I.

TABLE I

Requirement Codes

Annual Consumption	Requirement Code
Less than $8.00	1
$8.00 to $47.99	2
$48.00 to $287.99	3
$288.00 to $1727.99	4
Non-medical items	5*
$1728.00 and over	6
*Not subject to dollar value parameters	

Economic Order Quantity. The EOQ, as described by AFM 67-1, Volume V, was developed to consider a combination of cost factors. It indicates the optimum order quantity that will minimize the cost of ordering and the cost of holding an inventory. The EOQ affects the number of requisitions initiated during the year (21:p.8-3). A value known as the EOQ factor (EOQF) is generated based on annual consumption costs. This factor can range from 30 to 365 days and is used in determining the reorder percentage necessary to calculate the quantity to

be ordered each cycle.

Pipeline Time. The moving average method is used to determine the mean pipeline time of receipts. The number of pipeline times utilized in the computation is determined by the requirement code of the specific item. The number of pipeline values used according to each requirement code is shown in Table II (22:p.8-2).

TABLE II

Pipeline Time Factors

Requirement Code	Pipeline Time Factors
1	2
2	3
3	4
4	6
6	6

The formula for computation of pipeline time is:

$$PLT = \frac{1}{PLF} \sum_{i=1}^{PLF} P_i$$

where:

PLT = Pipeline Time

PLF = Pipeline Time Factor as specified by the Requirement Code

P_i = Most recent historical pipeline times

Daily Demand Rate. The DDR is computed using the sum of the issues in the available consumption history divided by the

number of days in the consumption history up to 365 days. The formula for computation is:

$$DDR = \frac{1}{D} \sum_{i=1}^{D} ISS_i$$

where:

DDR = Daily Demand Rate

ISS_i = Daily Issues

D = number of days in consumption history, limited to a maximum of 365 days

It should be noted that once the item's consumption history has reached 12 months, the number of days in the consumption period is set at 365 days (22:p.8-2).

Safety Stock Level. In this system, the safety level is simply fixed at one month of stock based on the previous 12-month average. The safety stock level is figured as follows:

$$SSL = \frac{1}{m} \sum_{i=1}^{m} D_i$$

where:

m = months of history consumption, not to exceed 12 months

D_i = actual demands for the ith month

Based on the annual dollar value of consumption, a Safety Level Factor (SLF) is provided in the computation of the Stock Control Level described below. This SLF is the number of days' supply to be ordered depending on the requirement code and the number of months of history consumption available. If the consumption

is less than 6 months, the SLF is equal to 15 days, and if the consumption history is for more than 6 months, the SLF is equal to 30 days (21:p.8-5).

Stock Control Level. After each of the above described variables has been determined, the SCL is then computed according to the following formula (21:p.8-4):

$$SCL = (SLF \times DDR) + (EOQF \times DDR) + (PLT \times DDR)$$

Reorder Percentage and Reorder Point. The Pipeline Time, Safety Level Factor, and FOQ Factor are used in the formula to compute the desired reorder percentage, which is subsequently used to determine the numerical reorder point. The ratio of factors for determining the ROP is:

$$ROP = \frac{PLT + SLF}{PLT + SLF + EOQF}$$

This value (ROP) is then applied against the SCL to determine the reorder point (RP):

$$RP = ROP \times SCL$$

Seasonality

Most inventory systems allow for certain fluctuations in lead time and demand by incorporating a safety level. This works adequately for those items whose lead time and demand fluctuate according to random variations to a normal distribution. The safety level is designed to accommodate a certain standard deviation from this norm. There are, however, many items whose demand fluctuations follow other than a normal

distribution over a 12-month period (6:31-35). Some items are demanded only during certain months of the year and possibly only one or two months of the year. If this demand follows a pattern from year to year, the items should be considered to be seasonal and should be treated in a special manner. Retail businesses generally handle seasonal items on an exception basis. For example, a sporting goods store increases the level of ammunition on hand just prior to hunting season and allows the level to drop much lower during nonhunting seasons. Commercial department stores typically build up inventories just before Christmas in anticipation of increased sales during that season. These stores usually liquidate their seasonal assets at the end of the season by having clearance sales. By eliminating the inventory of off-season items, firms can then afford to invest in other areas of interest. It appears that most of these seasonal adjustments are done heuristically. If an inventory is managed by a computer, the manager must override the recommendations of the computer and establish levels based on the past year's history. AFM 67-1, Volume V, even specifies that "variations in stock control levels and EOQs may be necessary for certain items under certain conditions," such as "seasonal items with negligible off-season consumption [21:p.8-4]." With the number of line items being managed in the medical inventory, it becomes impossible to manually control all items that exhibit seasonal trends. This is exemplified in the case of Insect Sting Kits in the inventory at the USAF Medical Center, Wright-Patterson AFB, Ohio. These particular kits show a history consumption of

24 in April, 24 in June, 36 in July, 12 in August, and zero in the following eight months. The computer calculated the SCL to be 24; therefore, 24 kits remained on the shelf for eight months with no consumption. Another example relates to the demand for calamine lotion. With a stock control level of 113 bottles, the consumption history revealed that issues were made for only five months out of the year. Therefore, 113 bottles of lotion remained idle on the shelf for seven months (19).

The Medical Materiel Management System presently has no effective method of automatically adjusting levels for seasonal items. In this Air Force medical inventory system, funds are invested in inventories for all seasons at all times of the year. The same balance of stocks is carried in the inventory when known seasonal trends exist. There is little logic for maintaining a fixed safety stock on items in the inventory when seasonal trends exist. There is a

> . . . tremendous opportunity for reducing investments and improving service in field stocks by basing safety stocks on a measurement of the errors actually experienced, in contrast to the naive methods of setting safety stocks as so many weeks of supply [5:44-45].

All stock levels are based on the probability that demands will not exceed availability based on historical records. For example, if a stock level of five items exists for a certain item in season and demands for six items occur, it is logical to conclude that this is a condition similar to having a level of zero in an off-season and experiencing a demand of one. In either case, arrangements must be made to procure the necessary item. Since all stock levels are based on a projection of the past, it is

reasonable to follow trends from previous years and adjust the levels accordingly, even if that requires maintaining a level of zero. The flexibility exists in the MMMS to maintain levels of zero by giving the materiel manager the authority to override the computer at his discretion (21:p.8-4). Therefore, it seems appropriate that some method be incorporated into the computer program to allow automatic adjustments to be made for seasonal items.

Chapter III

RESEARCH METHODS

Introduction

The data generated by the current MMMS inventory model are vital to this research effort. Therefore, the purpose of this chapter will be to identify the origin of the data, the specific data selected for analysis, and the data validity. This chapter will also be devoted to defining the criteria used in screening the data for seasonality and explaining some specific forecasting techniques that were applied to those seasonal items identified. The assumptions and limitations necessary for this study are included at the end of the chapter.

Population and Sample Description

The population of interest for this research consists of the various medical supply accounts Air Force-wide. Each of these accounts maintains computer products necessary for inventory control. The control system is updated daily using the base level Burroughs B-3500 computer. Each inventory account item has pertinent data stored in a master record on a computer tape. The information on the master record is maintained between processing cycles and can be accessed as needed by requesting a Stock Status Report. The report is a computer printout that arranges the data on the master record in a

logical form for management analysis. The key data on this report include the stock number, item identification, procurement source, historical issues for the past twelve months (demand data), reorder percentage and quantity, expendability code, requirement code, and the most current order lead times. The material manager for each account must review this data and insure it is properly updated and maintained.

The master record contains one year of past consumption history for each inventory item. This data is updated monthly by replacing the oldest month of data with the new. Because of this continuous updating process, vital historical data are removed from the computer from cycle to cycle. However, the historical events are preserved on monthly computer printouts, and these are maintained for one year by each account manager before being destroyed. The lack of year-to-year historical data in the medical inventory system has made it difficult to identify long-range trends in stock usage. The lack of this yearly historical data is also the primary reason why there have not been any known studies on seasonality in the MMMS structure. Captain Richard W. Ferguson indicates in his research that seasonal trends appeared to be present, but he could not confirm his hypothesis with only one year of data (8:18).

Based partially on Captain Ferguson's research recommendations and because of the growing interest in the high cost of managing the MMMS, the Air Force Data System Design Center (AFDSDC) requested computer tapes of the inventory master records from four Air Force Base Hospitals over two separate

years. The bases selected were Scott, Offutt, Blytheville and Whiteman. The time periods covered on the tapes were calendar years 1975 and 1977. Mr. Larry Prior, AFDSDC, released the data tapes from Offutt and Whiteman for this research effort. Upon receipt of these tapes, the question arose about the one year gap in the data. Mr. Prior's response to this question was, "These are the only known data files that are from different time periods [15]." The same year gap was also present in the data tapes from Scott and Blytheville. Therefore, the information provided on the data tapes for Offutt and Whiteman will be the sample data used for this research. The extent to which the findings of this research can be generalized to the entire population may be limited because of the gap in the data and the fact that these bases do not represent a random sample. Although, the research findings may be representative of what could be expected at any of the stock fund accounts, since these accounts are constrained and operated in a similar fashion.

The data furnished by AFDSDC was examined for all requirement codes in the drug and biological class (6505) only. The reason for selecting this particular class is that it is the largest, single class of inventory items and, partially, because of the need to narrow and limit the scope of this research. Also, it logically follows that if seasonality is present in this specific class, it is highly probable that it will be present in all others.

Validity

The data recorded on the tapes being used in this

research come from daily transactions and events. AFM 167-240 outlines the computer system utilized to accumulate this data. The mathematical model formulating the basis of the system has been tested previously for statistical accuracy and validity (8:34). Since the MMMS is the only source of such data, it is the most valid source available.

Analysis of Data

The initial approach that was taken to analyze the data tapes was to develop a FORTRAN program which could extract 6505 class data (see Appendices B & C). This program was designed to read through the data for 1975 and 1977, selecting only those items from the 6505 class for further analysis. Within the program it was also necessary to limit the data search to those stock numbers with at least twelve months of consumption history. The reason for this limitation is that in order to make viable comparisons between the years, complete consumption data must be available. This information is provided for each stock number as the History Begin Date (HBD). Only items with histories beginning December 1974 or earlier were considered.

The next critical step in analyzing the data involved establishing some criteria that could be used to select those items that exhibited seasonal variation. After close examination of several computer printouts of demand history, it was apparent that many of the stock numbers in the 6505 class exhibited demand fluctuations that very likely could be termed seasonal. Based on statistical estimation techniques, the maximum expected random variation in demand will generally not

exceed three standard deviations, since three standard deviations include 99.72 percent of all fluctuations during any time period (4:104). Research indicates that the standard deviation is the proper measure of demand error (5:45). Utilizing this concept, it was discovered heuristically that whenever the magnitude of demand for any one month was greater than two standard deviations from the mean, that particular stock number exhibited a discernable pattern of demand that could possibly be seasonal. Further evidence, supported statistically, indicates that almost two-thirds of all random fluctuations should fall within a range of one standard deviation from the mean and, therefore, the odds are heavily against purely random variations that consistently fall outside the range of one standard deviation (1:314). If the average demand does vary from the mean more than one standard deviation for several months running, the odds are that this is not a random fluctuation, but probably the result of some nonrandom factor, possibly seasonal in nature (1:315). With this understanding and considering the result of the heuristic evaluation, one standard deviation was established as the basic criteria for seasonal screening. Any stock number with average demand for several consecutive months exceeding one standard deviation from the mean demand was considered a seasonal item (26).

Several consecutive months could range from two months upward. However, for the purpose of this study, three months was determined to be the best discriminator of seasonality. By scanning several stock numbers that appeared to have seasonal

variation, the apparent trend occurred most often for three months in duration. This is supported logically, since many diseases occur with greater frequencies during the different natural seasons of the year, which are typically three months in duration. With this final criterion established, the original FORTRAN program was revised to identify any stock numbers whose average demand for three consecutive months exceeded one standard deviation. This selection criterion was formulated with the realization that there may be seasons of different lengths that may not have an average fluctuation exceeding one standard deviation; however, statistically and logically, this criterion should capture the bulk of those items which are seasonal.

Analysis of Forecasting

As stated in Chapter II, the MMMS uses the Simple Moving Average technique to forecast demand. The following formula is basic to all moving average models (16:87):

$$F_{n+1} = \frac{\sum_{i+1}^{n} \text{Demand}_i}{n}$$

where

F_{n+1} = the forecast for the next period

Demand_i = actual demand for period

n = the number of periods of demand being considered

The simple moving average forecast (F_{n+1}) is calculated by dividing the sum demands in the last n periods by n. This is

the simplest form of an estimate for the mean value of a stationary demand process (10:15). The overall effect of using the simple moving average is that demand fluctuations over the n periods are averaged out and the effects are not as noticeable. This means that any seasonal variations that may exist are largely smoothed out using the simple moving average technique. "A simple moving average is not sufficiently accurate to reflect what we truly can know about demand [4:85]." The failings of the moving average method can be overcome by using another forecast technique known as exponential smoothing.

"The exponential smoothing method of forecasting is a form of weighted averages and moving averages combined [8:26]." The disadvantages of the moving average method can be minimized by using exponential smoothing. Under the moving average method, equal weights are assigned to all data inputs in the forecasting of future demand. However, the exponential smoothing method uses varied weights and the data can be weighted depending on its importance. The following formula depicts the exponential smoothing process (16:91):

$$U_{t+1} = Y_t + (1 - \alpha) U_t$$

A smoothing constant (α) between 0 and 1 is used to add or subtract a fraction of the difference between the actual current demand (Y_t) and the last forecast demand (U_t). The sensitivity of the exponential smoothing forecast can be altered at any time by changing the value of α. An increased value of α gives more weight to recent data and, therefore, makes the forecast

more sensitive. Conversely, a smaller value of α gives less weight to recent data. For the moving average method, the sensitivity can only be altered by changing n; however, the forecast cannot be as significantly affected in the next period as it can be with the exponential smoothing method. Another important feature of exponential smoothing is that it only requires one piece of information to be retained from period to period. Also, past data are eliminated gradually rather than suddenly, as with the moving average (10:16).

The exponential smoothing technique, as previously described, is superior to the moving average technique in many ways. However, this primary form of exponential smoothing is not as efficient as desired when forecasting seasonal variations or taking into account linear trends in the data (16:94). To develop an equation that takes into account seasonal trends in the data and uses the weighted average concept, it is possible to refine the first order exponential smoothing forecast by resmoothing the initial forecast in a similar equation. By doubly exponentially weighting this forecast, it is possible to predict future demands, trends within demand patterns, and seasonal variations, while, at the same time, eliminating the influences of random variations (8:27). The double exponential smoothing model is represented as follows (16:94):

$$U^2_{t+1} = \alpha\, U^1_{t+1} + (1 - \alpha)\, U^2_t$$

where

U^1_{t+1} = the First Order Exponential Forecast

U^2_{t+1} = the Double Exponential Forecast

U_t = the Previous Double Exponential Forecast

The accuracy of double exponential smoothing can also be varied by changing the smoothing constant (α) to add more or less weight to recent data, thereby achieving the best possible forecast.

It is apparent when using exponentially weighted averages for forecasting that if the value of α can be varied in sympathy with the demand situation, better forecasts are likely to result (25:34). For example, if the demand data are fluctuating rapidly, a large value of α is necessary to achieve the best forecast. When the demand is more stable, a low value of α is more appropriate. Considering these notions, Trigg and Leach have suggested a method of varying the value of α automatically so that it tracks demand fluctuations (17:52). This automatic mechanism is formally called Trigg's tracking signal. Its computation is as follows (17:51):

$$T_t = \bar{e}_t / M_t$$

where

T_t = Trigg's tracking signal

$\bar{e}_t$ = the Exponentially Weighted Average

M_t = Mean Absolute Deviation

and

$$M_t = \alpha \, | e_t | + (1 - \alpha) \, M_{t-1}$$

$$\bar{e}_t = \alpha \cdot e_t + (1 - \alpha) \, \bar{e}_{t-1}$$

M_{t-1} = Previous Mean Absolute Deviation

$\bar{e}_{t-1}$ = Previous Exponentially Weighted Average

$e_t = Y_t - \hat{Y}_t$

where

Y_t = Actual Demand

$\hat{Y}_t$ = Estimated Demand

Since Trigg's tracking signal automatically adjusts to varying demand, it can be used to replace α in the original exponential smoothing equation. By making this substitution, the model becomes adaptive in nature and has been named the Adaptive Response Rate Forecast (10:21). This method of forecasting is given by the formula below (10:22):

$$\tilde{U}_t = |T_t| Y_t + (1 - |T_t|) \tilde{U}_{t-1}$$

where

T_t = Trigg's Tracking Signal

Y_t = Actual Demand for Current Period

$\tilde{U}_t$ = Adaptive Response Rate Forecast

$\tilde{U}_{t-1}$ = Previous Adaptive Response Rate Forecast

This forecasting method is feasible since Trigg's tracking signal can only vary between 0 and 1, the same restriction placed on the smoothing constant α. When the data are fluctuating rapidly, a relatively high value of the tracking signal will be evaluated and, thus, the adaptive response rate forecast should be very sensitive, and when the demand

data are stable, the resulting value of the tracking signal should be small, resulting in a very stable forecast (10:22).

In consideration of the attributes of these three forecasting models, one function of this research was to evaluate each technique in the context of the available forecast data. Each technique was incorporated into the original FORTRAN program and relative comparisons have been made between the ability of each technique to forecast the demand for 1977 using 1975 data. These forecasts have been evaluated specifically for those items that have met the seasonal criteria established in the previous section. The Mean Square Error (MSE) was used to discriminate between the efficiency of each forecasting technique. According to Sullivan and Claycombe, the model that minimizes the MSE is often regarded as the best model for future forecasting (16:25). The MSE is calculated as follows (16:26):

$$MSE = \frac{\sum_{i-1}^{n} (e - a)^2}{n}$$

where

e = Estimated Demand

a = Actual Demand

n = Number of months being evaluated

Using these three forecast techniques and choosing the best MSE forecast, comparisons were made for both Offutt and Whiteman. General trends in seasonal variation were evaluated for both bases and the efficiency of each model was tested. A secondary analysis was also made to evaluate how well each forecasting

technique performed on the demand data that did not meet the seasonal criteria to assure that no degradation occurred on nonseasonal forecasts.

Assumptions and Limitations

The following assumptions were made in evaluating the data for this research.

1. Future monthly demand patterns will be similar from year to year.
2. The distribution used in calculating the MSE of demands was assumed to be normal based on the central limit theorem.
3. The tapes furnished by AFDSDC were accurate and valid as collected.
4. Delays due to inordinate lead times will be similar from year to year and will, therefore, balance each other.

The following limitations are provided to indicate potential problem areas:

1. Sporadic ordering by supply custodians in the hospital may have caused some distortion in the data.
2. Quarterly fund limitations could have distorted the data. These limitations exist annually and effects from year to year should be similar.
3. Physician turnover in the hospital may have forced a change in demand rates for varied medical items since some drug usage is a matter of physician preference.

4. Data are from 1975 and 1977, respectively, and it is unknown what happened in 1976.

Summary

In this chapter the source of the data has been identified, delimited and assumed valid. Specific data analysis criteria were established for screening seasonality and several forecasting techniques were presented, which were tested for their ability to forecast seasonal trends as well as normal demands. It should be emphasized again that the data sample, consisting of information from two specific Air Force bases over two separate years, is the only data of its kind available. The analysis of this unique data has allowed a meaningful study of seasonality in the MMMS and the realization of the objectives of this research. Various assumptions and limitations have also been presented to insure the proper perspective is taken toward this research.

Chapter IV

ANALYSIS

Introduction

The first section of this chapter comments on seasonal screening and the criteria used to identify seasonality. In the following section, the extent of seasonality is addressed using both figurative and graphic illustrations. The final section analyzes the performance of those forecasting models presented in Chapter III, and reports on the ability of each model to forecast seasonal demand as well as nonseasonal demand.

Criteria for Seasonality

Ammer states, "The simplest way to estimate seasonal fluctuation is to assume that the pattern that prevailed in the past will prevail in the future [1:311]." Almost every product or service is subject to some seasonal variation, and in most cases it is fairly easy to identify. Brown suggests that the past demand data be plotted and examined closely for seasonal trends (4:106). However, this is not always economical, especially when thousands of items are involved. One of the best ways to evaluate seasonal variation without plotting is to average the monthly data over one period and check for those months that deviate drastically from that average (1:312). The unanswered question that follows is: How much deviation is

drastic? The answer is not a precise one, although, as pointed out in Chapter III, it can be statistically and logically determined. The established seasonality criteria for data analysis states that, if the average demand for any three consecutive months has a fluctuation of more than one standard deviation from the mean demand, the item is classified as seasonal. This means that for three consecutive months, the demand is drastic enough and consistent enough to make it difficult to justify as a purely random fluctuation. This criteria provided a starting point for further seasonal analysis, however, it is not the optimum for discovering seasonality. The fact that certain inventory items meet this seasonal criteria is not a guarantee that they are, in reality, seasonal and will follow a similar month-to-month demand pattern year after year. This criteria can be tightened or loosened to achieve a spectrum of seasonal variation, and since this research team could not identify any particular knowledgeable source that could firmly establish the bounds of seasonal variation, this research method is just one of many possible approaches. Medical demand patterns can display seasonality for varying lengths, and it is impossible for one set of criteria to encompass all possible seasonal variations.

The seasonal criteria as described above were translated into the original computer program for initial data analysis (see Appendices A, B & C). This program was designed to scan the data tapes for both 1975 and 1977 and select those items in the 6505 class for a specified base (Offutt or Whiteman) that

met the criteria. The process was repeated until four temporary memory files were created with seasonal items corresponding to base and year combinations. These new memory files were scanned once again, selecting a random stock number from each file to visually verify seasonal fluctuations. The items selected by the computer have been graphed to illustrate the relative efficiency of the established seasonal criteria to identify seasonal variation (see Figures 3 - 6). By examining these randomly selected demand patterns, it is apparent that the established seasonal criteria is performing as it was theoretically hypothesized and actually desired.

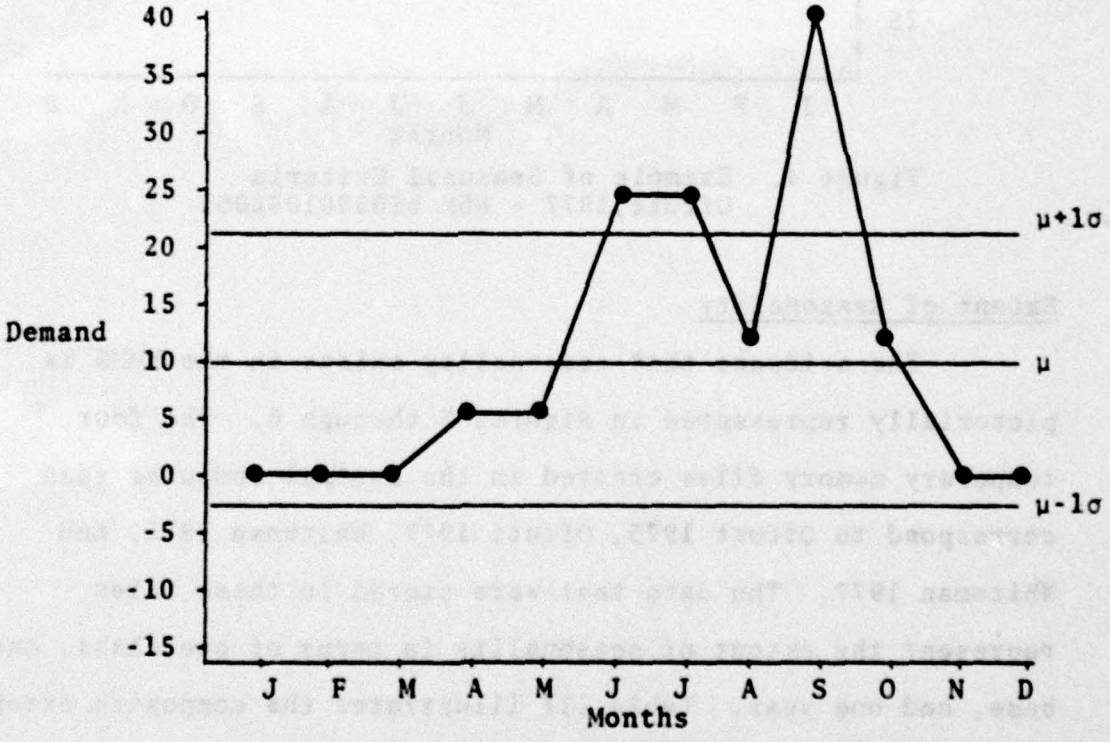


Figure 3. Example of Seasonal Criteria
Offutt, 1975 - NSN 6505001182318

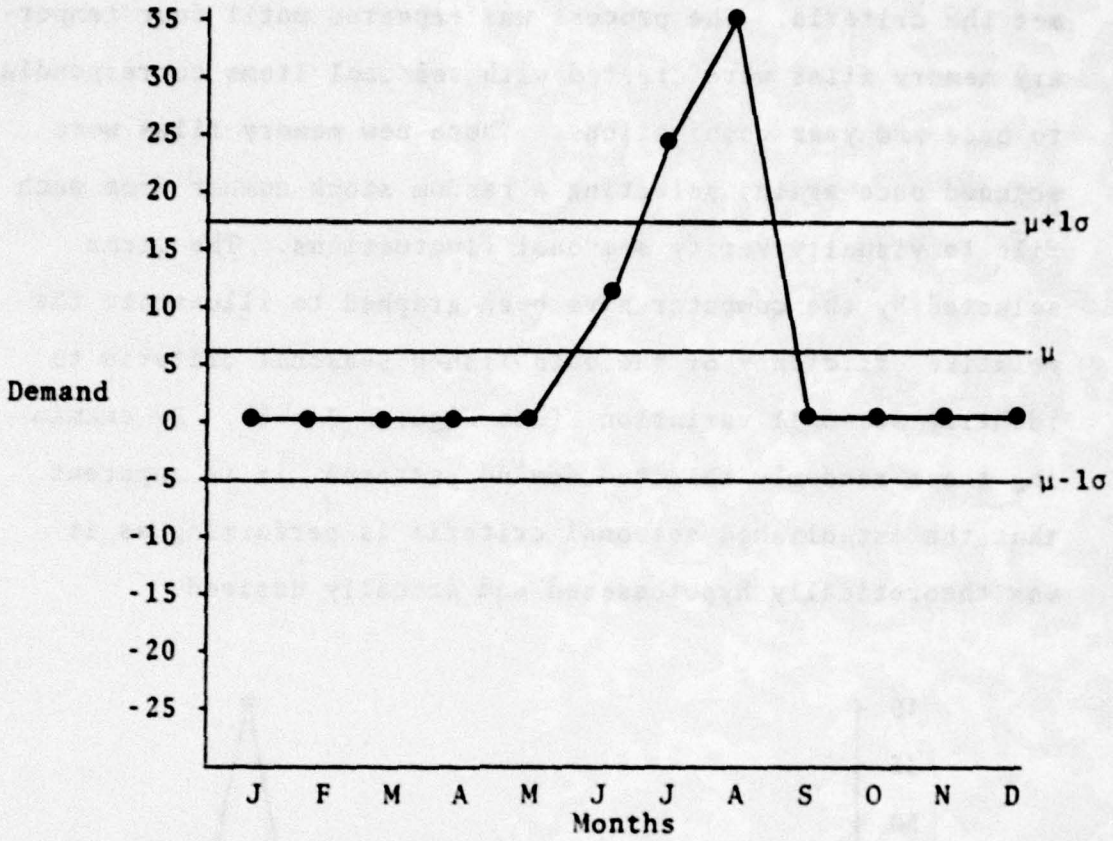


Figure 4. Example of Seasonal Criteria
Offutt,1977 - NSN 6505001048061

Extent of Seasonality

The evidence that seasonality exists in the MMMS is pictorially represented in Figures 3 through 6. The four temporary memory files created in the initial computer scan correspond to Offutt 1975, Offutt 1977, Whiteman 1975, and Whiteman 1977. The data that were stored in these files represent the extent of seasonality in terms of one class, one base, and one year. Table III illustrates the composite extent of seasonality.

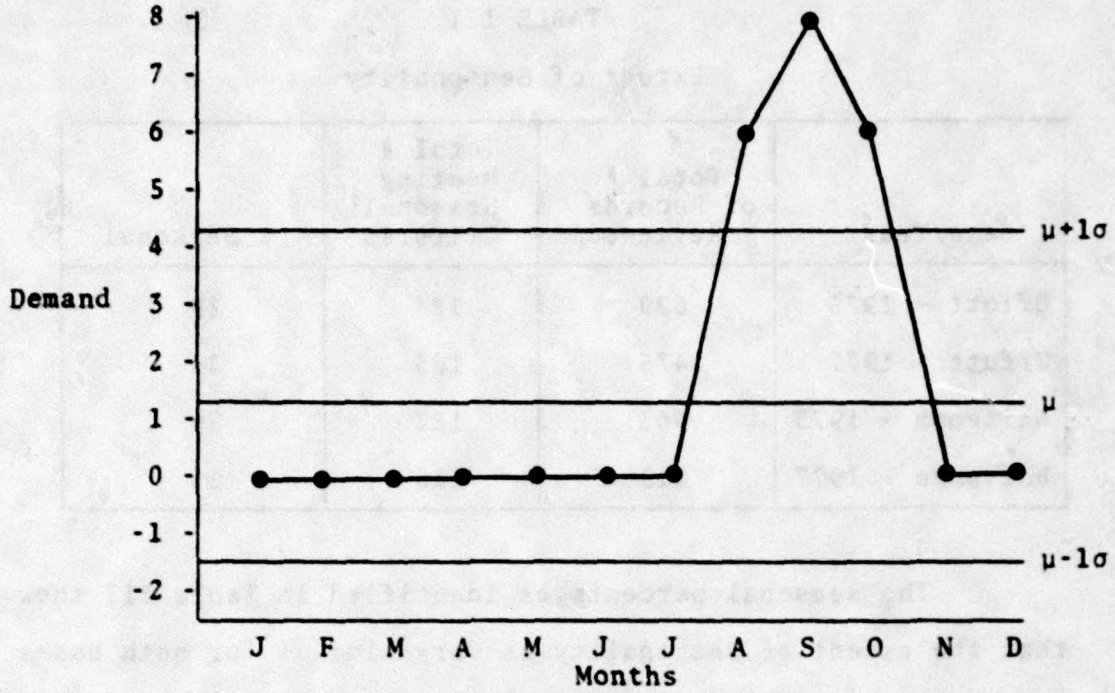


Figure 5. Example of Seasonal Criteria
Whiteman, 1975 - NSN 6505008901573

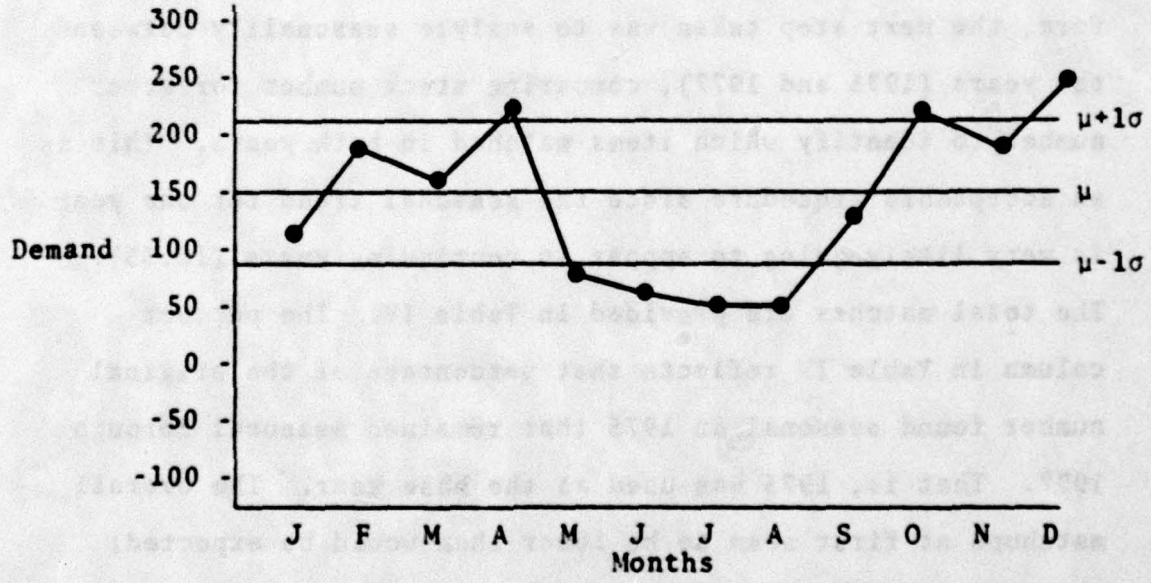


Figure 6. Example of Seasonal Criteria
Whiteman, 1977 - NSN 6505009354095

TABLE III

Extent of Seasonality

Base/Year	Total # of Records Reviewed	Total # Meeting Seasonal Criteria	% Seasonal
Offutt - 1975	629	184	29
Offutt - 1977	475	165	34
Whiteman - 1975	463	122	26
Whiteman - 1977	319	116	35

The seasonal percentages identified in Table III show that the extent of seasonality is very similar for both bases and both years (25-35% range), even though the original number of 6505 inventory records were significantly different. Therefore, the next step taken was to analyze seasonality between the years (1975 and 1977), comparing stock number for stock number to identify which items matched in both years. This is an acceptable procedure since the seasonal trend for one year is very likely going to appear in continuing years (16:55). The total matches are provided in Table IV. The percent column in Table IV reflects that percentage of the original number found seasonal in 1975 that remained seasonal through 1977. That is, 1975 was used as the base year. The overall matchups at first seem to be lower than would be expected; however, these percentages are for only one of several inventory classes and there is a year of missing data that could possibly explain the magnitude of similarity.

TABLE IV

Comparison of Year to Year Seasonality

Offutt				
Year	Total Records Scanned	Total # Seasonal	Total # Seasonal Matches	Year to Year Percent Seasonal (1975 Base Year)
1975	629	184	58	9%
1977	475	165		
Whiteman				
Year	Total Records Scanned	Total # Seasonal	Total # Seasonal Matches	Year to Year Percent Seasonal (1975 Base Year)
1975	463	122	35	8%
1977	319	116		

The matchups made for each base between 1975 and 1977 were next transferred to another computer subprogram, where they were used to construct graphic illustrations of the demand pattern similarity from year to year. Figure 7 depicts the typical product from this computer analysis.

Sample graphic illustrations as observed in Figure 7 are available for each stock number that was identified as seasonal in 1975 and remained seasonal in 1977 (see Appendix D). These graphs are particularly pertinent since they indicate the percentage of demand in each month compared with the total demands for the year. This allows both years' demands to be displayed on the same scale for easy comparison of trends. By

BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006561466

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	12	84	0	24	156	12	148	48	0	0	24
1977	0	0	12	0	0	24	0	24	12	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
632.17	42	42	41	35	35	33	22	21	11	8	8	8

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
147.77	19	11	5	7	5	2	11	8	14	14	8	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
136.33	20	24	7	8	10	9	4	18	9	14	13	10

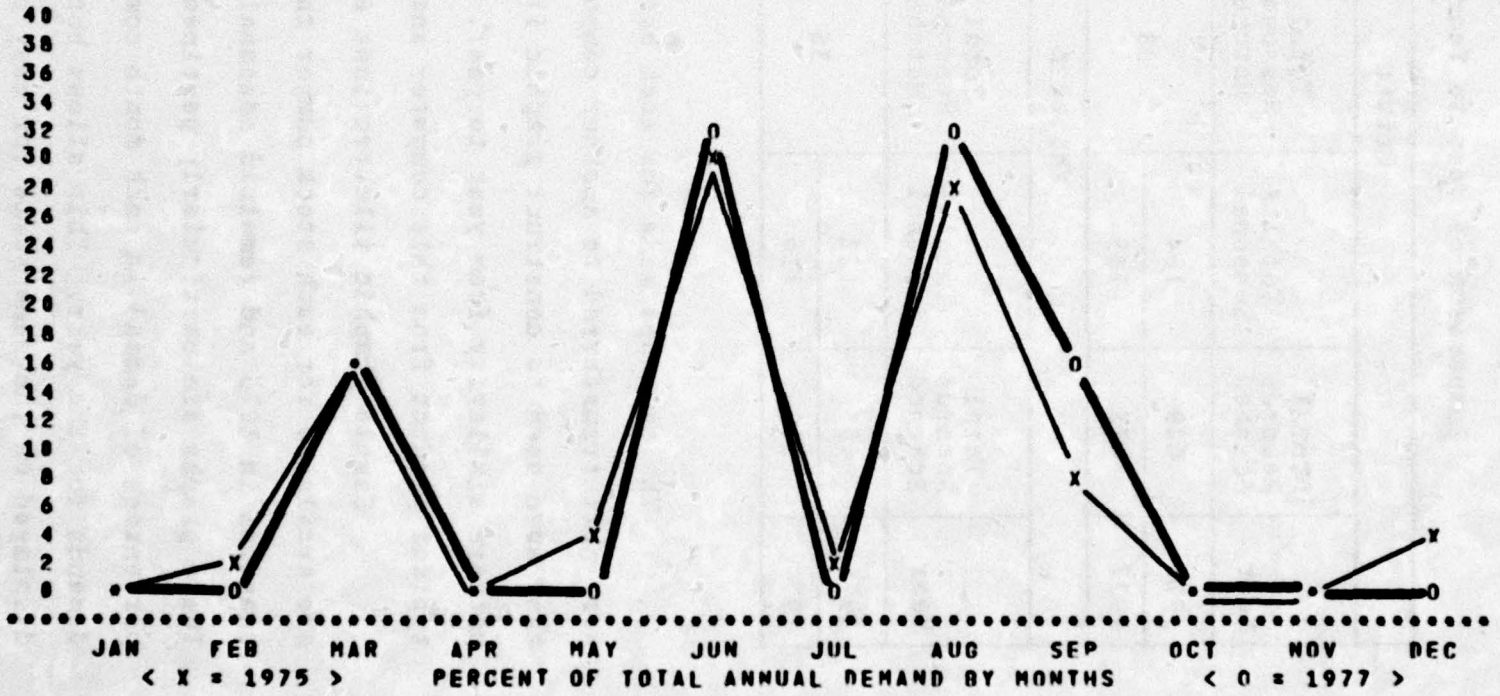


Figure 7. Sample Seasonal Output

close observation of these graphs, it can be seen that some items follow a very obvious trend in both years that can be equated as typical seasonal variation. Other graphs have a vertical gap between the yearly patterns, yet the peaks and valleys coincide exactly. Then, there are those that have a horizontal as well as a vertical variance between years. Closer examination of these graphs often shows that the peaks and valleys are off by just one time period, which is a common occurrence in reality, since seasons are not always exactly the same year after year. This is a reflection of the fact that flu seasons, for example, or similar disease seasons, vary somewhat from year to year, depending on numerous variables among which natural seasonal changes are the most important.

The one-for-one correlations between years of seasonally selected items is not as substantial as expected (8-9%), however, there are some explanations for such a variance. The obvious explanation was hinted at earlier and relates directly to the one year gap in the data base. It is impossible to ascertain the exact effect of this data void, although it is highly probable that the effect is not favorable. The missing data for 1976 makes it difficult to evaluate trends through the 1975 to 1977 time frame. The underlying reasons for the variations observed in Appendix D could be better explained if the 1976 data were available for comparison.

During the 1975 to 1977 time frame, new items were being added to the inventory and old ones were eliminated on a continuous basis. This changing nature is centered around two

basic occurrences. The first relates to new medical technology which is constantly improving medical supplies, resulting in the replacement of older stock with more advanced items. The second occurrence deals with the high changeover rate of Air Force medical doctors, which creates instability in drug usage. As new doctors come into the clinics, they bring their biases, not only in terms of drug prescription, but the use of other medical supplies. This change in usage causes the demand for certain drugs to drop off enough to make it uneconomical to continue an item in the inventory system. Closely associated with the doctor turnover rate is the changing of specialists, who require new and different equipment, drugs, and supplies. The ultimate result of these occurrences is a changeover of demand from one type of stock to another. This characteristic change is not as violent for a one-year period, but there can be significant differences over a two-year time frame. The researchers feel this can explain a large portion of the variance in the extent of seasonality between 1975 and 1977. The gap in this data represents a quantum leap in demand patterns, and this would not be expected in a continuous sequence of events.

Another underlying cause for the lack of continued seasonality, which is increased due to the data gap, relates to the procedures used in ordering stock and the level in the organization where ordering is accomplished. The demand data used for this study was intermediate in nature. The data do not reflect actual customer demands for a certain period, but

rather, they represent clinic demands on the central warehouse. The ordering policies are uniformly outlined in the operations manual, however, it is hard to discount human intervention within the system. For example, some clinic stock clerks feel it is appropriate to order one month's worth of supplies at a given order point, then at the very next order point, will often double or triple the order to prevent having to order so often. If this convenience method of ordering goes unchecked, it will have a substantial effect on the MMMS demand patterns, reflecting spurious inputs that could be mistaken for seasonal variation. Yearly and quarterly fiscal constraints can also cause demand changes from period to period, even though there is not actually that level of customer demand to support such a change. This spurious demand is depicted graphically in the data as a dropping-off of demand in December, followed by a rapid spike in January when more money is available. Similar results can be observed at other quarterly intervals (see Appendix D). Generally, it is expected that these variations will average out and represent a relative picture of the demand, however, this cannot be substantiated by the data analyzed.

In summary, the extent of seasonality has been determined by analysis of available data, although the results appear to be impaired significantly by the gap in the data. Based on the analysis findings, it can be inferred that about 9% of the stock numbers in the 6505 class display some sort of seasonal variation on a consistent basis. Had the data been continuous, the researchers speculate that this percentage would

be noticeably greater. Considering that the resulting extent of seasonality is for the 6505 class only, this implies that there is a potential for higher levels and that significant savings in inventory stock can be made if these seasonal variations can be accounted for. The next section will address forecasting based on this perception.

Evaluation of Forecasting

Under the current MMMS operating structure, the Medical Supply Officer and his staff must manually manage inventory items that exhibit unusual seasonal trends and fluctuation (21: p.8-3). However, the evidence of seasonality within the MMMS suggests that this must be an extensive and time consuming task to efficiently perform. Suitable adjustments can be made through the forecasting mechanism to automatically account for seasonality (17:59). Currently, the only forecasting mechanism in the MMMS model is the simple moving average technique, using an average of the previous twelve months' demand as its forecast. This is not the most efficient forecast mechanism. The simple moving average can be adjusted by varying the number of periods that are averaged. Although it cannot account for random fluctuation and actual seasonal trends and variations at the same time. The forecasting technique that is more suitable is the exponential smoothing method. The first order exponential smoothing model outperforms the moving average. And, when this initial smoothed forecast is resmoothed or doubly exponentially smoothed, the new forecast has a greater ability

to forecast trends and seasonal variations. Both forms of exponential smoothing can be adjusted for sensitivity by changing the smoothing constant. Yet, there is another forecasting technique, referred to as the Adaptive Response Rate, that has all the attributes of exponential smoothing, plus the ability to automatically adjust to demand fluctuations. All three of these forecasting techniques have been discussed and fully explained in Chapter III. The forecasting ability of each (Moving Average, Double Exponential Smoothing, and Adaptive Response Rate) has been tested and the following paragraphs outline the results.

Those stock numbers that were screened as seasonal in both 1975 and 1977 are the basis for the forecasting evaluations conducted. The primary focus of this analysis was to demonstrate the ability of each of the above techniques to take the actual demand data from 1975 and forecast 1977 demand. The formulas for these three forecasting techniques were studied in detail. The moving average model tested was the same twelve-period model now used for the MMMS. The double exponential smoothing model was used because of its ability to handle seasonality. A range of smoothing constants from .05 to .95 was evaluated for this model in increments of .05. The adaptive response rate technique was used in a similar manner, where a variation was added to the tracking signal. It was also given a range of smoothing constants from .05 to .95. The main computer program with these forecasting subprograms was linked with the matched seasonal data from both bases.

TABLE V

Best Seasonal Forecaster

Base	Simple Moving Average		Double Exponential Smoothing		Adaptive Response Rate	
	#	%	#	%	#	%
Offutt	6	10%	27	47%	25	43%
Whiteman	5	14%	11	32%	19	54%
Both	11	12%	38	41%	44	47%

Note: For replication of the results from the Double Exponential Smoothing and Adaptive Response Rate forecasts, it is necessary to point out that a priming forecast value was required in the initial stage of implementation. This estimated value was obtained by averaging the first three months of demand in 1975 (16:93).

The actual forecast values for each stock number evaluated are available for review in Appendices D and E. The triple asterisk (***) was used to identify the best performing model based on the minimum MSE. Table V depicts the cumulative results of all forecast models to predict seasonality.

By examination of Table V, it is apparent that the Adaptive Response Rate model was best 47% of the time for both bases. This model outperformed both of the competing models with the Double Exponential Smoothing model being a very close second. However, a more significant point in this evaluation is that when comparing Double Exponential Smoothing to Moving Average alone or Adaptive Response Rate to Moving Average alone, they both are better by a vast margin (84% and 64% respectively).

TABLE VI

Seasonal Moving Average Comparisons

Base	Simple Moving Average		Double Exponential Smoothing	
	#	%	#	%
Offutt	8	14%	50	86%
Whiteman	7	20%	28	80%
Both	15	16%	78	84%
Base	**Simple Moving Average**		**Adaptive Response Rate**	
	#	%	#	%
Offutt	22	38%	36	62%
Whiteman	12	34%	23	66%
Both	34	36%	59	64%

See Table VI for these comparisons. Almost as significant to this research as Table VI is, is the fact that when the Moving Average was the better model, there was a Double Exponential Smoothing model as good or very close to being as efficient. Table VII depicts this comparison, showing a relatively small difference in the MSE for each case.

When using the Double Exponential Smoothing model to forecast seasonal variation, a relatively larger smoothing constant is generally necessary to produce the best forecast. Brown has indicated that the value of α used in forming an exponentially weighted forecast should not usually exceed .3 and if it appears that a higher value of α is required, the

TABLE VII

Double Exponential and Moving Average

Comparison

Offutt NSNs	Moving Average MSE	Double Exponential MSE	Difference	%* Difference
6505002261203	80.00	80.75	.75	.9%
6505002998279	389.67	420.17	30.50	8%
6505008901633	63.75	67.42	3.67	7%
6505008902172	77.08	77.58	.50	.6%
6505009269202	46.75	50.78	3.83	8%
6505008718307	2.08	2.08	-0-	-0-
Whiteman NSNs				
6505008901573	8.50	8.92	.42	5%
6505008901657	1062.75	1229.33	166.58	15%
6505009984381	100.00	101.67	1.67	2%
6505007643366	.50	.50	-0-	-0-
65059040119	.58	.58	-0-	-0-

*Moving Average MSE was used as the base

assumption of seasonality is likely to be more valid (4:101). Figure 8 illustrates the number of times a given smoothing constant was required to produce the best double exponential model. The higher occurrence (54%) of the larger alphas ($\alpha > .3$) suggests that demand predominately had periods of fluctuations that were most likely seasonal. Figure 8 also depicts that a large percentage of smaller alphas were used in forecasting seasonal

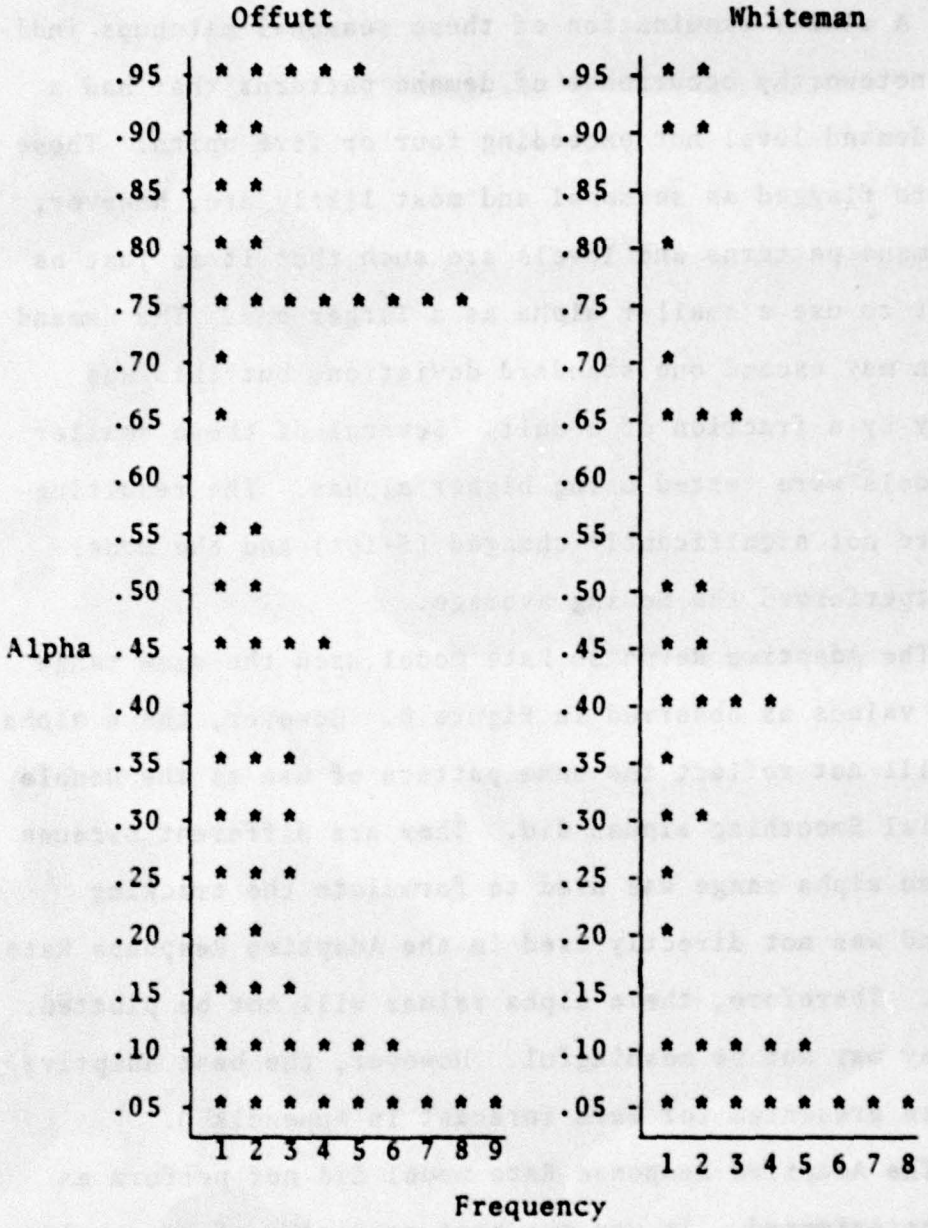


Figure 8. Seasonal Frequency of Smoothing Constant Occurrence (Double Exponential Smoothing)

demand. A closer examination of these seasonal matchups indicates a noteworthy occurrence of demand patterns that had a maximum demand level not exceeding four or five units. These items were flagged as seasonal and most likely are, however, their demand patterns and levels are such that it is just as efficient to use a smaller alpha as a larger one. The demand variation may exceed one standard deviation, but this was typically by a fraction of a unit. Several of these smaller alpha models were tested using higher alphas. The resulting MSE's were not significantly changed (5-10%) and the model still outperformed the moving average.

The Adaptive Response Rate model used the same range of alpha values as observed in Figure 8. However, these alpha values will not reflect the same pattern of use as the Double Exponential Smoothing alphas did. They are different because the varied alpha range was used to formulate the tracking signal and was not directly used in the Adaptive Response Rate forecast. Therefore, these alpha values will not be plotted, since they may not be meaningful. However, the best adaptive alphas are presented for each forecast in Appendix D.

The Adaptive Response Rate model did not perform as well as anticipated. It was the best predictor of seasonality, yet the Double Exponential Smoothing model was almost as good. Based upon the literature reviewed, the researchers felt the Adaptive Response Rate model would be the best of the three techniques used, however, the Double Exponential Smoothing model proved to be superior overall. Why the adaptive model

did not perform well is difficult to explain. When the adaptive model was compared directly with the moving average, it was better 64% of the time, but Double Exponential Smoothing was better 84% of the time. Further comparisons, similar to those presented in Table VII, indicate that the Adaptive Response Rate model is substantially worse than the Moving Average model when the Moving Average is better.

It appears from reviewing Appendix D that the adaptive method worked best when very sudden and extensive changes occurred in the demand. This model reacted quicker than the other competing models to these sudden changes, however, by doing so it may have responded to random fluctuations in demand, resulting in less accurate forecasts. Also, when the demand fluctuation dropped, the Adaptive Response Rate was slow to return. The most probable cause for this inefficient performance is that the data are limited in their extent and, for the most part, the items evaluated are not carried in sufficiently large quantities for the adaptive method to adjust correctly. Research of the Adaptive Response Rate literature also supports this contention. Data were evaluated for periods of five to ten years and heavy demand levels were observed (17:58). Although this model has its limitations, it remains a more efficient model than the moving average.

The results of the forecasting analysis clearly shows that for seasonal demand patterns the moving average is inadequate. Double Exponential Smoothing and Adaptive Response Rate models are the most promising techniques. Figure 9 shows

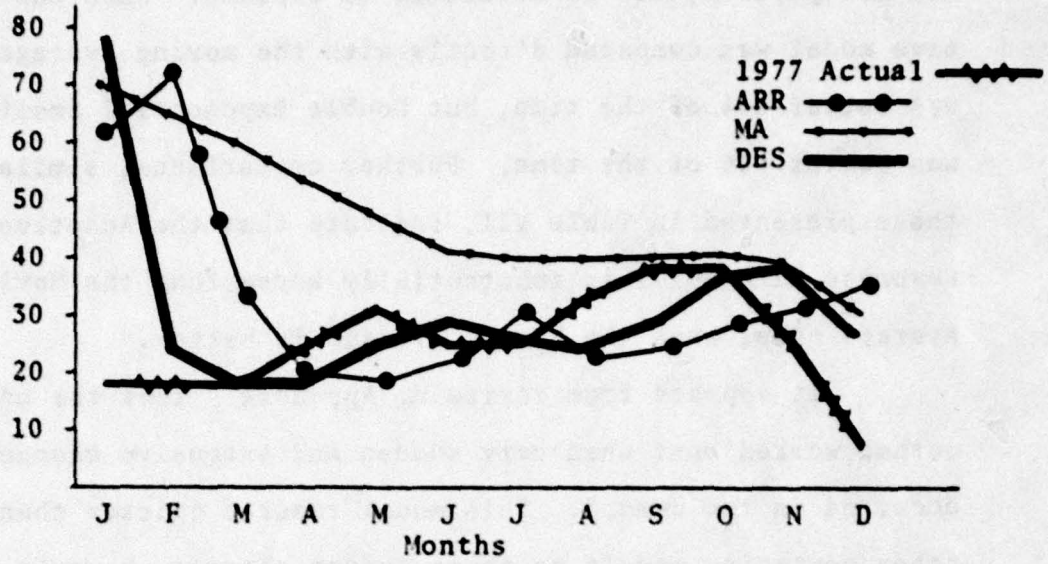


Figure 9. Seasonal Forecasting
Offutt, 1977 - NSN 6505002998598

a typical seasonal item, drawn from Appendix D, and illustrates how each model predicts the demand.

Figure 9 clearly demonstrates that seasonal variations can be accounted for by using the proper forecasting technique. However, to foster a change in the MMMS structure, it is important that the selected forecasting model not only have an ability to accurately forecast seasonality, but at the same time be able to forecast nonseasonal items with sufficient accuracy. In order to evaluate this requirement, the FORTRAN computer program was modified to select only those 6505 class items that did not meet the established seasonal criteria. Once these stock numbers were identified for each base for the two years, a one-for-one stock number comparison was made. After the matches were made and placed in memory, a random

generator picked a number from one through ten, and every fifth thereafter was identified. These randomly selected nonseasonal items were next read into each of the forecasting subprograms to determine once again which model was best. The MSE was again used as the discriminator. The results of this analysis are highlighted in Table VIII. A total of 56 items were selected from both bases. Appendices F and G contain a print-out for each nonseasonal item evaluated.

TABLE VIII

Best Nonseasonal Forecaster

Base	Simple Moving Average		Double Exponential Smoothing		Adaptive Response Rate	
	#	%	#	%	#	%
Offutt	2	6%	24	73%	7	21%
Whiteman	4	17%	15	66%	4	17%
Both	6	11%	39	70%**	11	19%

**Best model

The Double Exponential Smoothing model was again superior to both competing models. The Adaptive Response Rate was the second best. Figure 10 illustrates the typical demand pattern of a nonseasonal item and how each of the forecasting methods responded. Continuing analysis of these random nonseasonal items illustrates the fact that Double Exponential Smoothing is best 89% of the time when compared directly with the Moving Average. Moving Average was second best (see Table IX).

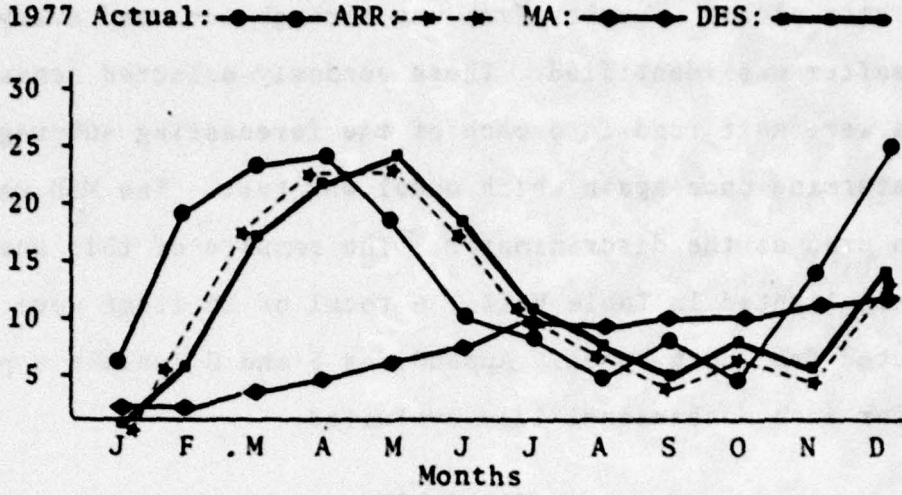


Figure 10. Nonseasonal Forecasting
Offutt, 1977 - NSN 6505007218899

TABLE IX

Nonseasonal Moving Average Comparisons

Base	Simple Moving Average		Double Exponential Smoothing	
	#	%	#	%
Offutt	2	6%	31	94%
Whiteman	4	17%	19	83%
Both	6	11%	50	89%
Base	**Simple Moving Average**		**Adaptive Response Rate**	
	#	%	#	%
Offutt	20	60%	13	40%
Whiteman	15	65%	8	35%
Both	35	63%	21	37%

Once again, when the moving average was best, there was a double exponential model that came very close to the same predictive ability. Table X shows these relative differences.

TABLE X

Double Exponential and Moving Average

Nonseasonal Comparisons

Offutt NSNs	Simple Moving Average MSE	Double Exponential Smoothing MSE	Difference	%* Difference
6505000797453	9.17	9.67	.50	6%
6505000765589	2.25	2.25	-0-	-0-
Whiteman NSNs				
6505001405150	3.08	3.08	-0-	-0-
6505001601500	1.33	1.33	-0-	-0-
6505002998617	.33	.33	-0-	-0-
6505005843470	49.58	54.25	4.67	9%

* Simple Moving Average MSE was used as the base

The best alpha smoothing constants for the double exponential smoothing model are referenced in Figure 11. Analysis of these constants indicates that the smaller alphas were used 66% of the time. This result is what was expected since the demand patterns for nonseasonal items should be fairly constant over the year. In addition, the reverse criteria used for seasonal selection was used to randomly select these nonseasonal

items. It is apparent that the criteria works in reverse as well as directly.

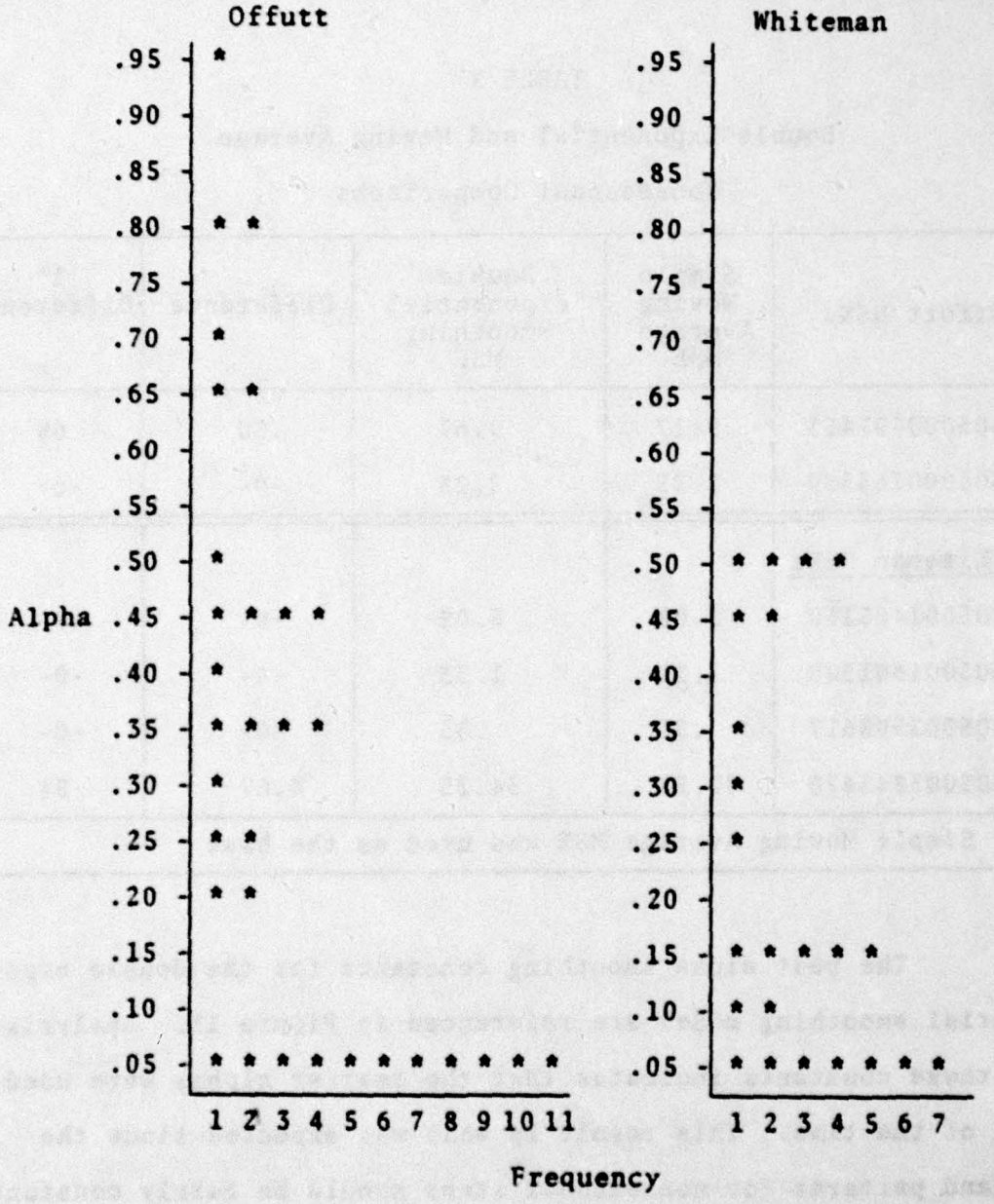


Figure 11. Nonseasonal Frequency of Smoothing Constant Occurrence (Double Exponential Smoothing)

Although the Adaptive Response Rate was the second best predictor for nonseasonal demand, it was actually the weaker model when compared directly with the moving average. Moving Average forecasts were better 63% of the time for both bases combined. This result is not surprising, since the Adaptive Response Rate is not designed to predict nonseasonal demand as efficiently as other models. If a spurious fluctuation is detected by the adaptive model, it rapidly adjusts to that demand level and this ultimately results in a higher MSE, which is undesirable. Considering these factors, the tabular comparisons of the Adaptive Response Rate with the Moving Average will not be presented.

One of the key assumptions that was made in analyzing these forecasting results is that demand patterns that were initially observed would continue into the future. This assumption would be easier to support if more than two years of consecutive data were available. The one year gap in the data used may have detracted somewhat from the forecasting efficiency. Despite this gap, the forecasting techniques used actually appeared to do an adequate job of forecasting 1977 using 1975 data. This lends credibility to the key assumption made. The researchers feel that a better forecast would be possible if 1975 data were used to predict 1976 demand and then using the continuous data for the 1977 forecasts. Nonetheless, the researchers are confident that the evaluations made on the three forecasting techniques are indicative of their relative ability to predict demand.

Summary

In this chapter the research data has been examined in support of the research objectives. As was mentioned earlier, the basic assumption for determining future seasonal trends and variations is based on the concept that trends which occurred in the past will occur again. Although the overall analysis was limited by having only two years of data from nonconsecutive years, seasonal trends were apparent from the data.

It was interesting to find that the most advanced forecasting technique, Adaptive Response Rate, did not prove to be superior to the other methods. Although the logic behind the Adaptive Response Rate leads one to believe it is the best, the Double Exponential Smoothing method was the better forecaster across the boad. The automatic screening of smoothing constants is a feature that was made possible by the computer and ultimately improved the ability of the Double Exponential Smoothing model to forecast varying demand patterns.

The analysis in this chapter supports the fact that a Simple Moving Average is not adequate to handle the demand variation observed in the MMMS. Both of the competing forecast methods accentuated this lack of efficiency. By incorporating advanced computer techniques with a more refined forecasting method, the need to manually account for seasonal trends and variations within the MMMS could be eliminated.

Chapter V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this research effort was to examine the demands for medical supplies within the Medical Materiel Management System to determine if seasonality exists, the degree to which it exists, and to offer suggestions for a better method of adjusting for it. This study was conducted at the suggestion of the USAF Surgeon General's Staff and the Air Force Data System Design Center, Medical Division. Previous studies of the medical inventory management and control procedures have not addressed seasonality specifically. The study was initiated with the idea that a more efficient management control system could be developed.

The initial step taken to resolve the seasonality issue required an indepth investigation into the medical inventory management and control system, inventory management concepts and theory, and forecasting techniques in general. The MMMS, as it currently operates, was described in context with long accepted inventory practices, and the research methods that would be used to analyze data for seasonality were explained.

The only data available for such a study was provided by the Air Force Data System Design Center, and consisted of

the master record tapes from Offutt and Whiteman AFBs for the calendar years 1975 and 1977. The data were assumed to be valid since they were actual demands recorded from daily base transactions. A utility FORTRAN program was developed to read the tapes, extract the necessary data, make comparisons, forecast future demand, and plot desired seasonal information. This computer program and its primary output products are available in Appendices C through G. Appendices A through B provide a list of variables and the computer logic used in the programming process.

Analysis of these results indicates that a significant amount of seasonality is present within the medical materiel inventories evaluated. Further evaluation of forecasting methodologies has demonstrated that Double Exponential Smoothing forecasts are superior to the current Moving Average forecasts 84% of the time when forecasting seasonal items and 89% of the time when forecasting nonseasonal items. These percentages followed the same pattern for each base analyzed. The similarity that exists between these nonrandom Air Force bases provide an indication that it would be useful to investigate the application of the results to the overall population.

Conclusions

The analysis of results obtained from this study indicate other areas that may be advantageous to MMMS and that could very likely reduce operating costs.

1. A change of algorithm for forecasting demands from

the Moving Average to Double Exponential Smoothing will provide superior demand estimates and should ultimately reduce cost since Double Exponential Smoothing provides better results most of the time. When Double Exponential Smoothing does not provide better results, they are no worse than Moving Average.

2. To provide for a thorough study of seasonality, at least three years of demand data should be retained for future research.

Recommendations for Future Study

During the pursuit of this research analysis, there were areas identified that could benefit from future study:

1. A more comprehensive examination should be conducted to identify savings associated with using Double Exponential Smoothing in the MMMS.

2. Because of the inherent problem with using non-consecutive data, replication of this seasonality study using consecutive data may provide a more precise picture of the total effects of seasonality.

3. A separate study should be undertaken to identify the effects of doctor changeover and their preferences for new or substitute medical supplies.

4. A closer examination should be made of the effects of fiscal constraints on this process.

5. The effect that inconsistent ordering practices have on the demand histories should be studied.

APPENDIX A

LIST OF VARIABLES

LIST OF VARIABLES

A	ALPHA READING OF ALL 12 MONTHS DEMAND HISTORY FOR BOTH YEARS DATA
AATO	NATO DESIGNATOR WITHIN STOCK NUMBER IN ALPHA FORM
ABD	HISTORY BEGIN DATE IN ALPHA FORM
ACL	STOCK CONTROL LEVEL IN ALPHA FORM
AFSC	FEDERAL STOCK CLASS IN ALPHA FORM
AHOLD	HOLDING VARIABLE TO RETAIN LOWEST VALUE OF MSE FOR DOUBLE EXPONENTIAL SMOOTHING FORECAST
AIIN	NATIONAL IDENTIFICATION INDEX NUMBER IN ALPHA FORM
ALFAOP	OPTIMAL ALPHA FOR ADAPTIVE RESPONSE FORECAST
ALPHA	SMOOTHING COEFFICIENT USED IN EXPONENTIAL SMOOTHING AND ADAPTIVE RESPONSE FORECASTING FORMULAS
ALPHOP	OPTIMAL ALPHA FOR DOUBLE EXPONENTIAL SMOOTHING
AM	VARIABLE USED TO FIND MAX PERCENTAGE OF 1975 DEMAND TO PRINT ON GRAPH
AMD	MAD (MEAN ABSOLUTE DEVIATION) FOR ADAPTIVE RESPONSE RATE FORECASTING FORMULA
AN	USED TO FIND MAX PERCENTAGE OF 1977 DEMAND TO PRINT ON GRAPH
AO	MAXIMUM VALUE FOR 1975 AND 1977 FOR GRAPH SCALE
AVG	MEAN ANNUAL DEMAND USED IN DETERMINING STANDARD DEVIATION FOR CRITERIA FORMULA
AVG3	AVERAGE DEMAND FOR FIRST THREE MONTHS OF 1975, USED FOR PRIMING IN DOUBLE EXPONENTIAL SMOOTHING AND ADAPTIVE RESPONSE FORECASTING FORMULAS
AZ	PLOTTING CHARACTER FOR SPACE, X, O, OR *
B	USED TO CALCULATE INDIVIDUAL MEANS FOR 3 MONTH PERIODS FOR CRITERIA FORMULA
BATO	1977 VALUE FOR NATO, USED IN COMPARISON TO 1975 DATA

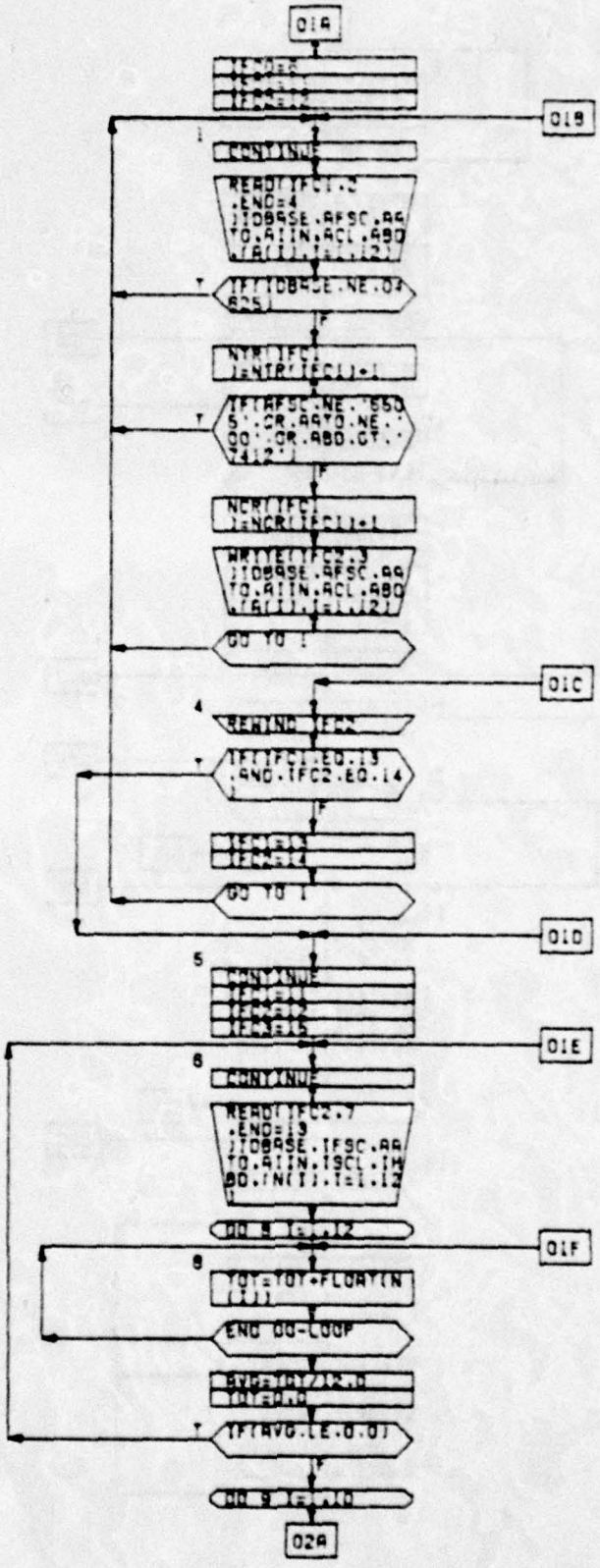
BEST	USED TO DETERMINE BEST FORECASTING METHOD
BETA	1-ALPHA IN DOUBLE EXPONENTIAL SMOOTHING AND ADAPTIVE RESPONSE FORECASTING FORMULAS
BHOLD	HOLDING VARIABLE TO HOLD LOWEST VALUE OF MSE FOR ADAPTIVE RESPONSE FORECASTING
BIIN	1975 VALUE FOR NATO USED IN COMPARISON TO 1977 DATA
C	USED TO FIND VARIANCE FOR COMPUTATION OF STD DEV
CC	PERCENTAGE VALUES FOR GRAPH
D	DEMAND PER MONTH FOR 1975, USED TO FIND PERCENTAGE OF ANNUAL DEMAND FOR GRAPH
DD	PERCENTAGE VALUES FOR GRAPH
DI	DOUBLE EXPONENTIALLY SMOOTHED FORECAST ESTIMATE
E	DEMAND PER MONTH FOR 1977, USED TO FIND PERCENTAGE OF ANNUAL DEMAND FOR GRAPH
EMAV	USED IN FINDING MSE IN MOVING AVERAGE FORMULA
ERRAR	MEAN SQUARED ERROR FOR ADAPTIVE RESPONSE
ERRDI	MEAN SQUARED ERROR FOR DOUBLE EXPONENTIAL
ERRMA	MEAN SQUARED ERROR FOR MOVING AVERAGE
ERROR	ACCUMULATES ERROR FOR DOUBLE EXPONENTIAL
ERRRR	ACCUMULATES MSE VALUES FOR ADAPTIVE RESPONSE
EWA	EXPONENTIALLY WEIGHTED AVERAGE FOR ADAPTIVE RESPONSE
EI	SINGLE EXPONENTIALLY SMOOTHED FORECAST ESTIMATE FOR DOUBLE EXPONENTIAL
I	DO LOOP INDEX
IAR	FORECAST FOR ADAPTIVE RESPONSE
IARSAV	FORECAST VALUES FOR 1977 ADAPTIVE RESPONSE FORECAST SAVED FOR PRINTING
IDBASE	BASE DESIGNATOR IN INTEGER FORM
IFC0	INDICATES DEVICE CODE 6
IFC1	FILE CODE FOR TAPES

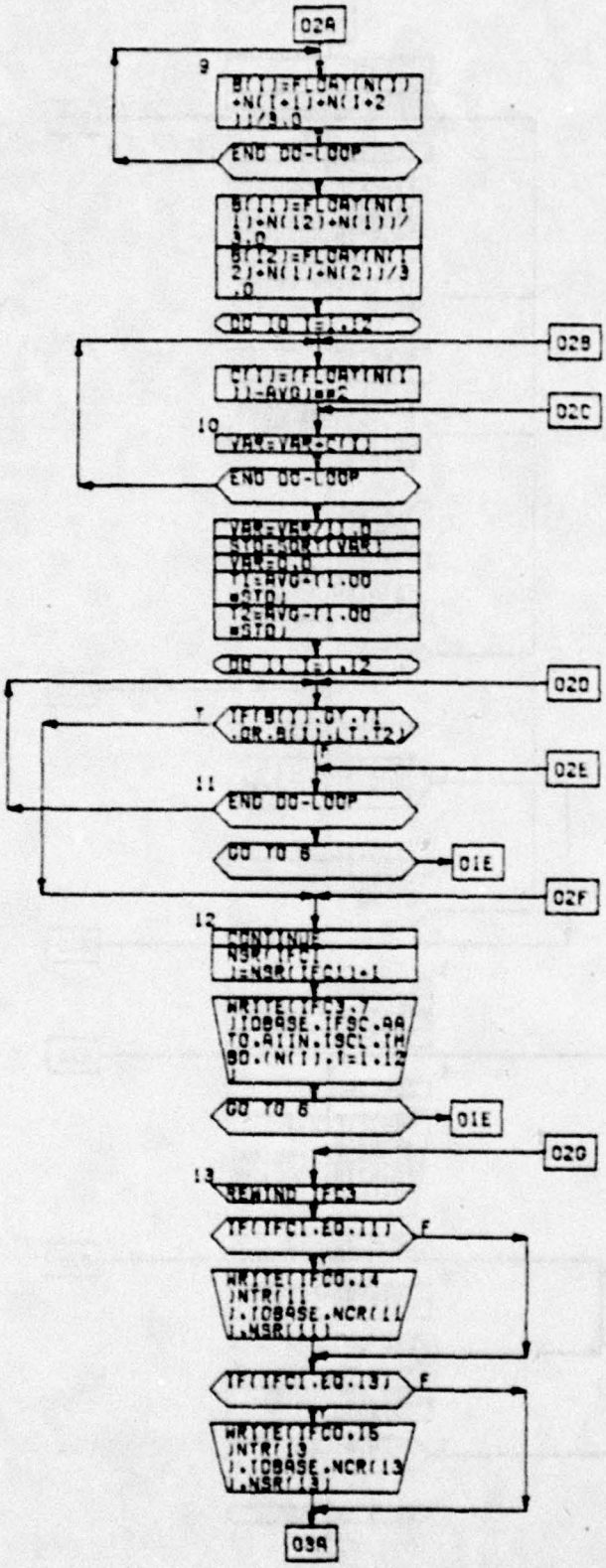
IFC2	FILE CODE FOR TEMP FILES
IFC3	CODE FOR INTERMEDIATE FILE FOR SEASONAL ITEMS
IFEROR	ABSOLUTE VALUE OF FORECAST ERROR IN ADAPTIVE RESPONSE RATE FORECAST FORMULA FORECASTING
IFERRR	ACTUAL VALUE OF FORECAST ERROR IN ADAPTIVE RESPONSE RATE FORECAST FORMULA FORECASTING
IFSC	INTEGER FORM FOR FEDERAL STOCK CLASS
ISAVE	RETAINED VALUE FOR THE BEST DOUBLE EXPONENTIAL SMOOTHING MSE
ISCL	INTEGER FORM FOR STOCK CONTROL LEVEL
ISKALE	SCALE USED FOR GRAPH, 0-100 OR 0-40 PERCENT
II	INTEGER FOR THE DOUBLE EXPONENTIAL SMOOTHING FORECAST
J	DO LOOP INDEX
JA	BASE ID FROM 75 FILE
JB	FEDERAL STOCK CLASS FROM 75 FILE
JE	STOCK CONTROL LEVEL FROM 75 FILE
JF	HISTORY BEGIN DATE FOR 75 FILE
K	DO LOOP INDEX
KA	BASE ID FROM 77 FILE
KB	FEDERAL STOCK CLASS FROM 77 FILE
KE	STOCK CONTROL LEVEL FROM 77 FILE
KF	HISTORY BEGIN DATE FROM 77 FILE
L	USED TO CALCULATE MOVING AVERAGE UPPER LIMIT
LABEL	CONVERTS IDBASE TO OFFUTT OR WHITEMAN
LABEL1	PRINTS FLAG FOR BEST MOVING AVERAGE MSE
LABEL2	PRINTS FLAG FOR BEST DOUBLE EXPONENTIAL MSE
LABEL3	PRINTS FLAG FOR BEST ADAPTIVE RESPONSE MSE

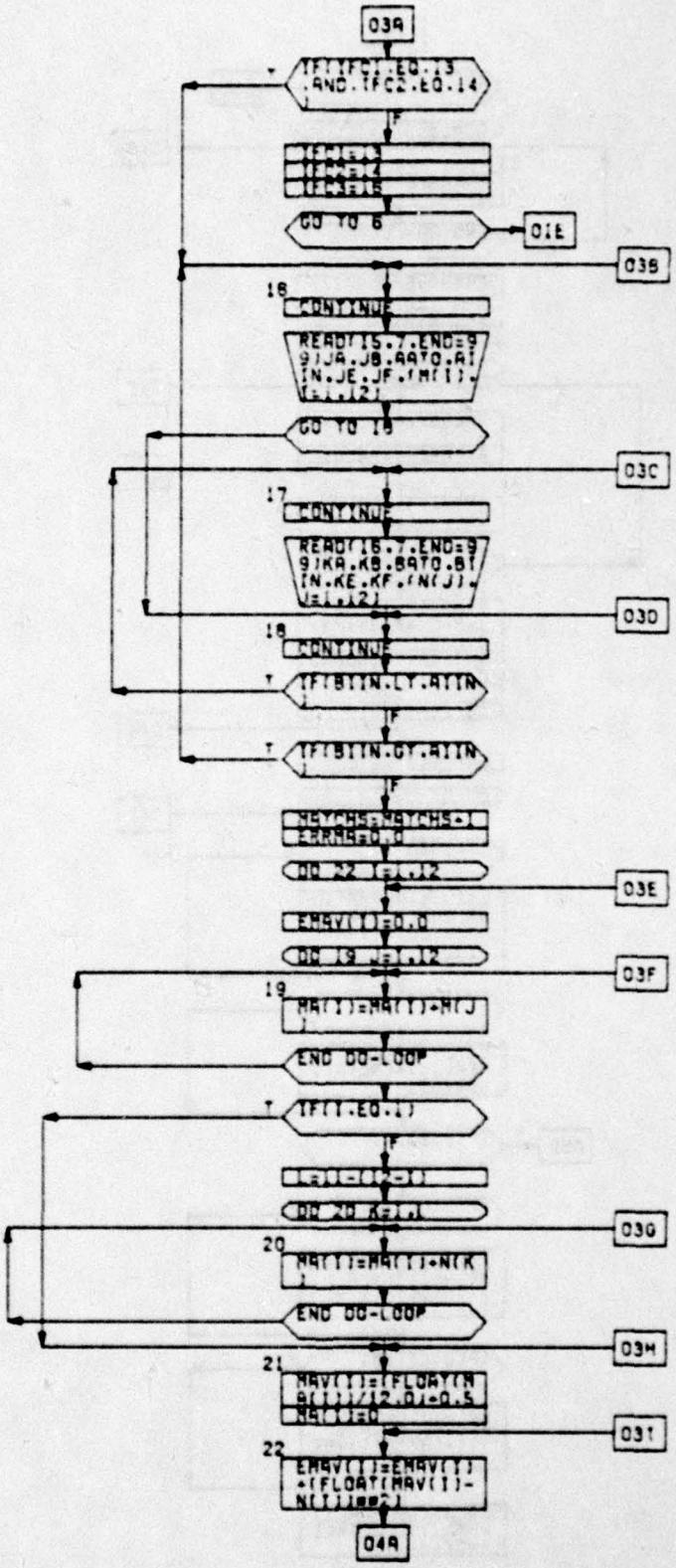
M	ACTUAL MONTHLY DEMAND HISTORY FOR 75
MA	USED IN CALCULATING MOVING AVERAGE
MAV	MOVING AVERAGE FORECAST VALUE
MATCHS	COUNTS NUMBER OF MATCHES FOR BOTH YEARS
N	ACTUAL MONTHLY DEMAND HISTORY FOR 77
NCR	COUNTER FOR NUMBER OF RECORDS THAT MEET SEASONAL CRITERIA IN 6505 CLASS FROM EACH BASE WITH HISTORY BEGIN DATE OF 7412 OR EARLIER
NSR	COUNTER FOR NUMBER OF RECORDS THAT ARE SEASONAL FROM EACH BASE
NTR	COUNTER FOR TOTAL RECORDS FOR EACH BASE
STD	STANDARD DEVIATION USED IN CRITERIA
TOT	TOTAL DEMANDS FOR YEAR USED IN CALCULATING STD
TOT1A	TOTAL 1975 DEMAND PER STOCK NUMBER, USED TO FIND PERCENTAGE OF DEMAND PER MONTH FOR GRAPH
TOT2A	TOTAL 1977 DEMAND PER STOCK NUMBER, USED TO FIND PERCENTAGE OF DEMAND PER MONTH FOR GRAPH
TRCK	TRACKING SIGNAL FOR ADAPTIVE RESPONSE FORECAST
VALUE	INCREMENT FOR SMOOTHED FORECAST IN DOUBLE EXPONENTIAL SMOOTHING, VARIES ALPHA VALUE
VAR	VARIANCE OF ACTUAL DEMAND USED TO CALCULATE STD

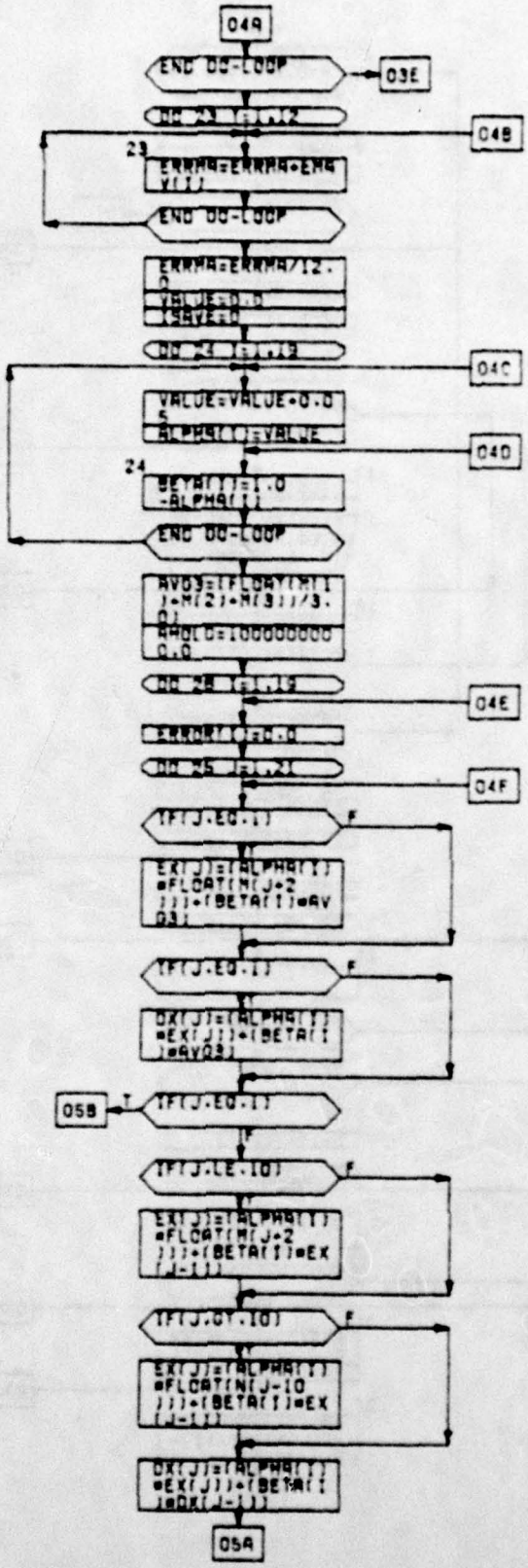
APPENDIX B

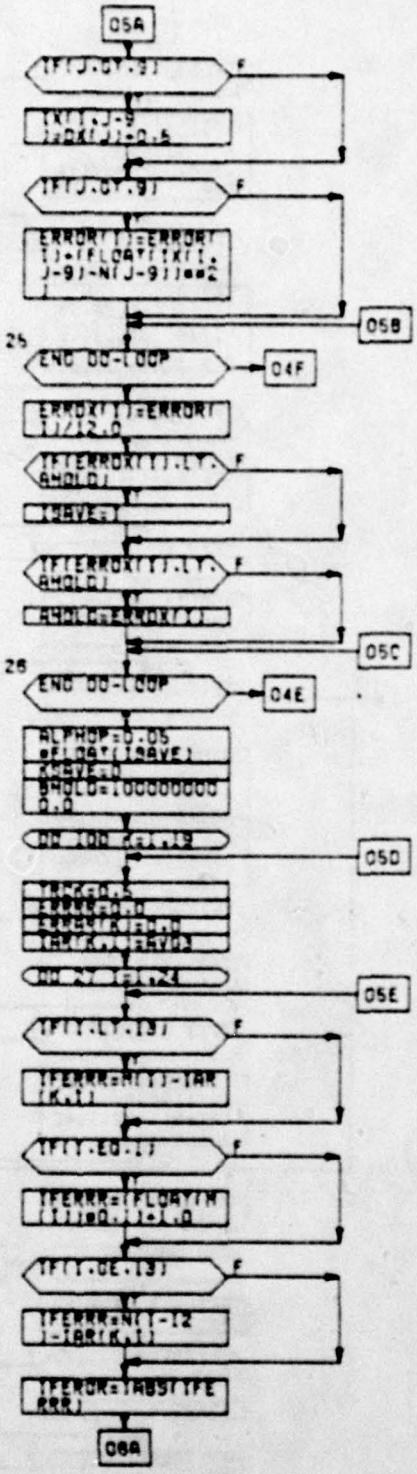
FORTRAN FLOWCHART

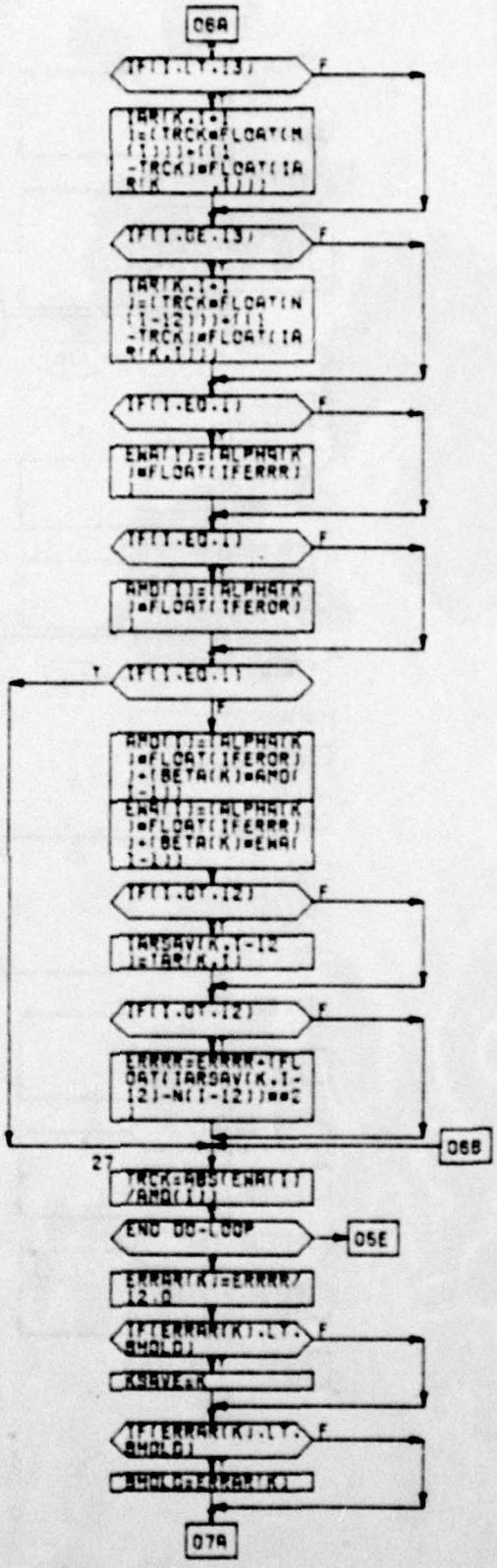

01A
01B
1
CONTINUE
READ(IFC1,2
,END=4
)IDBASE,AFSC,AA
TO,AIIN,ACL,ABD
,(AI(I),I=1,12)
IF(IDBASE.NE.02
ABS)
NTR(IFC)
=NTR(IFC)+1
IF(AFSC.NE.'55D
5'.OR.AATO.NE.'
00'.OR.ABD.GT.'
7412')
NCR(IFC)
=NCR(IFC)+1
WRITE(IFC2,3
)IDBASE,AFSC,AA
TO,AIIN,ACL,ABD
,(AI(I),I=1,12)
GO TO 1
01C
4
REWIND IFN
IF(IFC1.EQ.13
.AND.IFC2.EQ.14
)
GO TO 1
01D
5
CONTINUE
01E
6
CONTINUE
READ(IFC2,7
,END=9
)IDBASE,IFSC,AA
TO,AIIN,ISCL,IM
BD,IN(I),I=1,12
DO 8 I=1,12
01F
8
YOY=YOY+FLOAT(IN
(I))
END DO-LOOP
IF(AVG.LE.0.0)
DO 9 I=1,10
02A

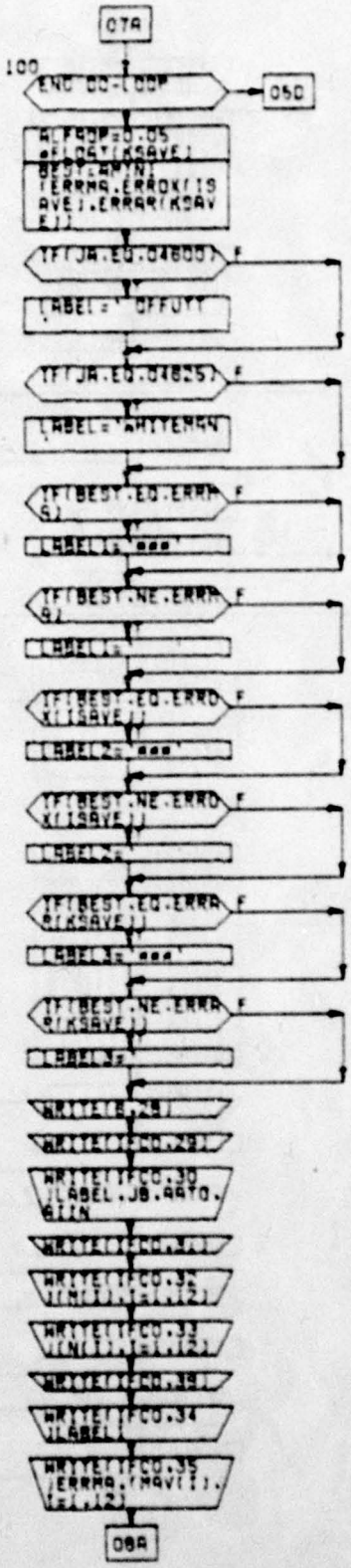

02A
9
B(I)=FLOAT(N(I)
+N(I+1)+N(I+2
))/3.0
END DO-LOOP
B(I)=FLOAT(N(I
))+N(2)+N(1))/
3.0
B(2)=FLOAT(N(I
2)+N(1)+N(2))/3
.0
DO 10 I=3,12
02B
C(I)=(FLOAT(N(I
))-AVG)**2
02C
10
VAR=VAR+C(I)
END DO-LOOP
VAR=VAR/11.0
STD=SQRT(VAR)
VAR=0.0
Y1=AVG-(1.00
*STD)
Y2=AVG-(1.00
*STD)
DO 11 I=1,12
02D
T
IF(B(I).GT.Y1
.OR.B(I).LT.Y2)
F
02E
11
END DO-LOOP
GO TO 8
01E
02F
12
NSR(IFC)
=NSR(IFC)+1
WRITE(IFC3,7
)IOBASE,IFSC,AA
TO,AIIN,ISCL,IM
SO,(N(I),I=1,12
)
GO TO 8
01E
02G
13
REWIND IFC3
IF(IFC1.EQ.11)
F
WRITE(IFCO,14
)NTR(1)
,IOBASE,NCR(1)
,NSR(1)
IF(IFC1.EQ.13)
F
WRITE(IFCO,15
)NTR(13
),IOBASE,NCR(13
),NSR(13)
039

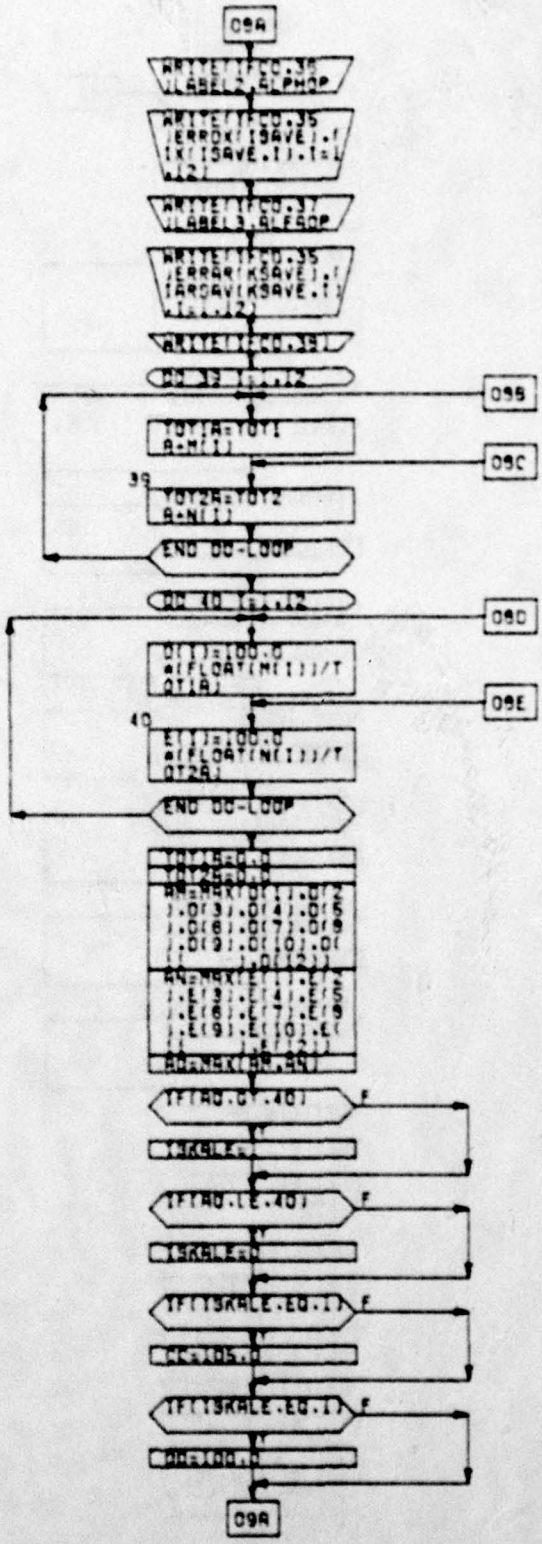

03A
IF(IFC1.EQ.13
.AND.IFC2.EQ.14
IF
GO TO 6
01E
03B
16
CONTINUE
READ(15,7,END=9
9)JA,JB,BATO,BI
IN,JE,JF,(M(I),
I=1,12)
GO TO 15
03C
17
CONTINUE
READ(16,7,END=9
9)KA,KB,BATO,BI
IN,KE,KF,(N(J),
J=1,12)
03D
18
CONTINUE
IF(BIIN.LT.AIIN
IF(BIIN.GT.AIIN
IF
MSYCHS=MSYCHS+1
EMNH=0.0
DO 22 I=1,12
03E
EMAV(I)=0.0
DO 19 J=1,12
03F
19
MA(I)=MA(I)+M(J
END DO-LOOP
IF(I.EQ.1)
IF
DO 20 K=1,1
03G
20
MA(I)=MA(I)+N(K
END DO-LOOP
03H
21
MAV(I)=(FLOAT(M
A(I))/12.0)+0.5
MA(I)=0
03I
22
EMAV(I)=EMAV(I)
+(FLOAT(MAV(I)-
N(I))**2)
04A

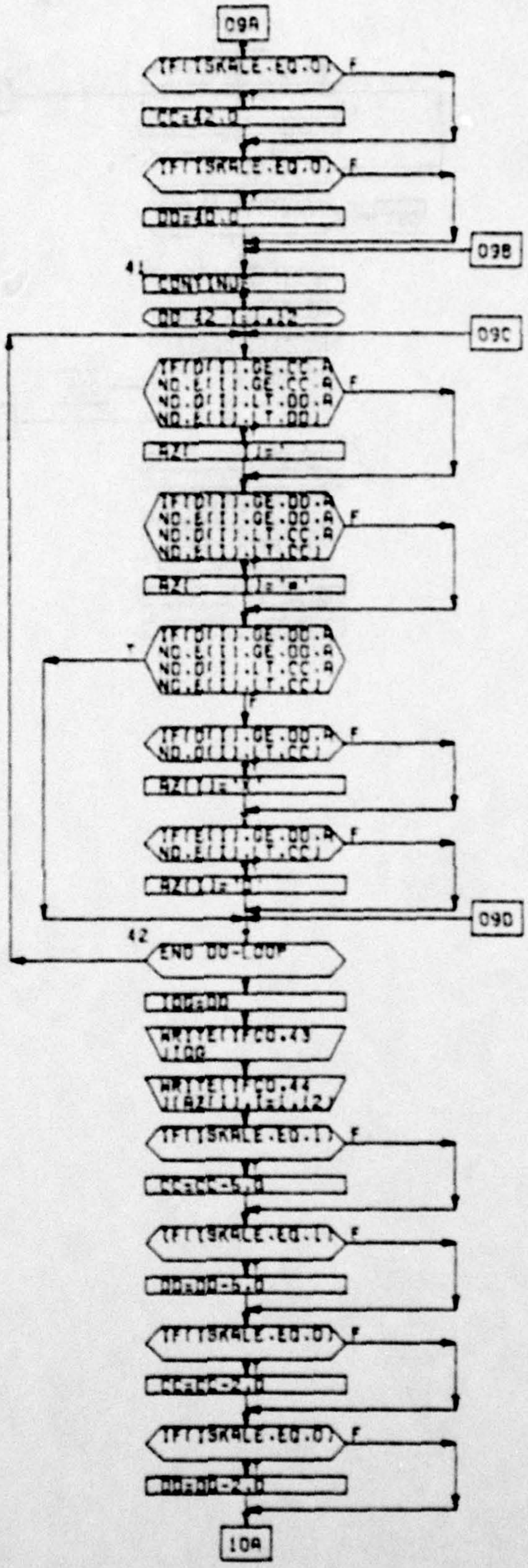

049
END DO-LOOP
03E
04B
23
ERRMM=ERRMM+EMG
Y(I)
END DO-LOOP
ERRMM=ERRMM/12.
0
VALUE=0.0
ALPHA(1)=0.0
04C
VALUE=VALUE+0.0
5
ALPHA(I+1)=VALUE
04D
24
BETA(I)=1.0
-ALPHA(I)
END DO-LOOP
AVQ3=(FLOAT(M(I
)+M(2)+M(3))/3.
0)
AMAX(1)=10000000
0.0
04E
ERRMAX(1)=0.0
04F
IF(J.EQ.1)
F
EX(J)=(ALPHA(I)
*FLOAT(M(J+2
)))+(BETA(I)*AV
Q3)
IF(J.EQ.1)
F
DX(J)=(ALPHA(I)
*EX(J))+(BETA(I
)*AVQ3)
058
T
IF(J.EQ.1)
F
IF(J.LE.10)
F
EX(J)=(ALPHA(I)
*FLOAT(M(J+2
)))+(BETA(I)*EX
(J-1))
IF(J.GT.10)
F
EX(J)=(ALPHA(I)
*FLOAT(M(J-10
)))+(BETA(I)*EX
(J-1))
DX(J)=(ALPHA(I)
*EX(J))+(BETA(I
)*DX(J-1))
05A

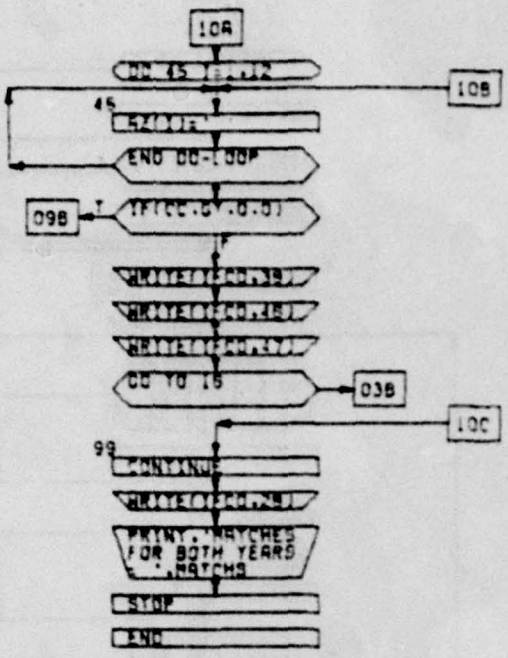

05A
IF(J.GT.9)
F
IX(I,J-9
)=DX(J)+0.5
IF(J.GT.9)
F
ERROR(I)=ERROR(
I)+(FLOAT(IX(I,
J-9)-N(J-9))**2
)
05B
25
END DO-LOOP
04F
ERROR(I)=ERROR(
I)/12.0
IF(ERROR(I).LT.
AMOLD)
F
IWAVE=I
IF(ERROR(I).LT.
AMOLD)
F
AMOLD=ERROR(I)
05C
26
END DO-LOOP
04E
ALPHOP=0.05
*FLOAT(IWAVE)
ZMAVE=0.0
BMOLD=10000000
0.0
DO 100 Z=1,12
05D
IWAVE=0
ERROR=0.0
ZMAVE=Z+0.0
AMOLD=AMOLD
DO 90 I=1,24
05E
IF(I.LT.13)
F
IFERR=N(I)-IAR
(K,I)
IF(I.EQ.1)
F
IFERR=(FLOAT(N
(I))/0.1)*1.0
IF(I.GE.13)
F
IFERR=N(I)-12
)-IAR(K,I)
IFERR=IABS(IFE
RR)
08A


06A
IF(I.LY.13)
F
[AR(K,I+
]=(TRCK*FLOAT(M
(I,I))+(1.
-TRCK)*FLOAT(IA
R(K,I)))
IF(I.GE.13)
F
[AR(K,I+
]=(TRCK*FLOAT(M
(I-12,I))+(1.
-TRCK)*FLOAT(IA
R(K,I)))
IF(I.EQ.1)
F
EWA(I)=(ALPHA(K
)*FLOAT(IFERR)
IF(I.EQ.1)
F
AMO(I)=(ALPHA(K
)*FLOAT(IFEROR)
IF(I.EQ.1)
T
F
AMO(I)=(ALPHA(K
)*FLOAT(IFEROR)
)+(BETA(K)*AMO(
I-1))
EWA(I)=(ALPHA(K
)*FLOAT(IFERR)
)+(BETA(K)*EWA(
I-1))
IF(I.GT.12)
F
[ARSAV(K,I-12
]=[AR(K,I)
IF(I.GT.12)
F
ERRRR=ERRRR+(FL
OAT(IARSAV(K,I-
12)-N(I-12))**2
068
27
TRCK=ABS(EWA(I)
/AMO(I))
END DO-LOOP
05E
ERRAR(K)=ERRRR/
12.0
IF(ERRAR(K).LY.
RHOLD)
F
KSAVE=K
IF(ERRAR(K).LY.
RHOLD)
F
RHOLD=ERRAR(K)
07A


07A
100
END DO-LOOP
050
IF(JA.EQ.04800)
LABEL='OFFUYY'
IF(JA.EQ.04825)
LABEL='AHYYEHGG'
IF(BESY.EQ.ERRA
G)
IF(BESY.NE.ERRA
G)
IF(BESY.EQ.ERRO
R(ISAVE))
IF(BESY.NE.ERRO
R(ISAVE))
IF(BESY.EQ.ERRA
R(KSAVE))
IF(BESY.NE.ERRA
R(KSAVE))
WRITE(IFCO,30
WRITE(IFCO,34
WRITE(IFCO,35
08A


09A
WRITE(IFCD,35
(LABEL2,ALPHOP
WRITE(IFCD,35
(ERROR(ISAVE),(
IX(ISAVE,I),I=1,
NI2)
WRITE(IFCD,37
(LABEL3,ALFROP
WRITE(IFCD,35
(ERROR(KSAVE),(
IROOV(KSAVE,I),
NI=1,12)
WRITE(IFCD,38)
DO 12 I=1,12
09B
YOY1A=YOY1
A=N(I)
09C
39
YOY2A=YOY2
A=N(I)
END DO-LOOP
DO 10 I=1,12
09D
D(I)=100.0
*(FLOAT(N(I))/T
OT1A)
09E
40
E(I)=100.0
*(FLOAT(N(I))/T
OT2A)
END DO-LOOP
YOY1A=0.0
YOY2A=0.0
AA=HER(D(1),D(2
),D(3),D(4),D(5
),D(6),D(7),D(8
),D(9),D(10),D(
11),D(12))
AA=HER(E(1),E(2
),E(3),E(4),E(5
),E(6),E(7),E(8
),E(9),E(10),E(
11),E(12))
BB=HER(BB,BB)
IF(AA.GT.40)
F
T
ISKALE=1
IF(AA.LE.40)
F
T
ISKALE=0
IF(ISKALE.EQ.1)
F
T
CC=100.0
IF(ISKALE.EQ.1)
F
T
BB=100.0
09A


09A
IF(ISKALE.EQ.0)
IF(ISKALE.EQ.0)
09B
41
CONTINUE
09C
IF(D(I).GE.CC.A
ND.E(I).GE.CC.A
ND.D(I).LT.DD.A
ND.E(I).LT.DD)
IF(D(I).GE.DD.A
ND.E(I).GE.DD.A
ND.D(I).LT.CC.A
ND.E(I).LT.CC)
IF(D(I).GE.DD.A
ND.E(I).GE.DD.A
ND.D(I).LT.CC.A
ND.E(I).LT.CC)
IF(D(I).GE.DD.A
ND.D(I).LT.CC)
IF(E(I).GE.DD.A
ND.E(I).LT.CC)
09D
42
END DO-LOOP
IF(ISKALE.EQ.1)
IF(ISKALE.EQ.1)
IF(ISKALE.EQ.0)
IF(ISKALE.EQ.0)
10A


10A
10B
45
END DO-LOOP
098
038
10C
99
STOP
END

APPENDIX C

FORTRAN PROGRAM

```
100000$,R(IZL) :,8,16
10100:IDENT:WP1185,AFIT/LSG CIL OHL WEL
10200:OPTION:FORTRAN,NOMAP
10300:FORTY:NFORM,NLNO,NLSTIN,IREF
1040C
1050C       ************************************************************
1060C       *                                                          *
1070C       *       A FORTRAN PROGRAM DESIGNED TO PERFORM              *
1080C       *                                                          *
1090C       *  AN EVALUATION OF SEASONALITY IN THE UNITED STATES       *
1100C       *     AIR FORCE MEDICAL MATERIEL MANAGEMENT SYSTEM         *
1110C       *                                                          *
1120C       ************************************************************
1130C
1140 DIMENSION NTR(20),NCR(20),W(12),C(12),WSR(20),M(12),D(12),E(12)
1150 DIMENSION MA(12),MAV(12),EMAV(12),ALPHA(20),BETA(20),ERRAR(12)
1160 DIMENSION EX(24),DX(24),ERROR(10),ERRDI(10),IX(20,12)
1170 DIMENSION AMD(24),EWA(24),IAR(20,24),IARSAV(10,12),B(12)
1180 CHARACTER AFSC*4,AATO*2,AIIN*7,ACL*6,ABD*4,A*6(24),LABEL1*3
1190 CHARACTER LABEL*8,BATO*2,BIIN*7,AZ*1(12),LABEL2*3,LABEL3*3
1200C
1210C     INITIALIZE READ & WRITE FILE/DEVICE CODES (IFC0 = 6, WHICH IS THE
1220C     LINE PRINTER;  IFC1 = 11, WHICH IS THE TAPE CONTAINING 1975 DATA;
1230C     IFC2 = 12, WHICH IS THE FIRST SCRATCH-FILE TO STORE 1975 DATA THAT
1240C     MEETS THE FOLLOWING CRITERIA:  BASE = OFFUTT;  STOCK-CLASS = 6505
1250C     NATO DESIGNATION = 00;  HISTORY BEGIN DATE LESS THAN 7412)
1260C
1270 IFC0=4
1280 IFC1=11
1290 IFC2=12
1300C
1310 1 CONTINUE
1320C
1330C     READ DATA TAPE AND WRITE THOSE RECORDS MEETING THE ABOVE CRITERIA
1340C     TO A SCRATCH-FILE FOR FURTHER PROCESSING LATER
1350C
1360 READ(IFC1,2,END=4)IDBASE,AFSC,AATO,AIIN,ACL,ABD,(A(I),I=1,12)
1370 2 FORMAT(I4,2I,A4,A2,A7,183I,A6,300I,A4,79I,12A6)
1380 IF(IDBASE.NE.0446)GO TO 1
1390C
1400C     COUNT THE NUMBER OF DATA RECORDS FOR EACH BASE FOR BOTH YEARS
1410C
1420 NTR(IFC1)=NTR(IFC1)+1
1430 IF(AFSC.NE."6505".OR.AATO.NE."00".OR.ABD.GT."7412")GO TO 1
1440C
1450C     COUNT NUMBER OF DATA RECORDS (FROM SPECIFIC BASE) MEETING CRITERIA
1460C
1470 NCR(IFC1)=NCR(IFC1)+1
1480 WRITE(IFC2,3)IDBASE,AFSC,AATO,AIIN,ACL,ABD,(A(I),I=1,12)
1490 3 FORMAT(I5,1X,A4,1X,A2,1X,A7,1X,A6,1X,A4,12A8)
1500C
1510C     RETURN TO '1 CONTINUE' TO READ THE NEXT RECORD
1520C
1530 GO TO 1
```

```
1540C
1550C     WHEN THE END-OF-FILE FOR THE DATA TAPE IS ENCOUNTERED, REWIND THE
1560C     NEWLY CREATED SCRATCH-FILE TO ALLOW IT TO BE READ AT A LATER POINT
1570C
1580 4 REWIND IFC2
1590C
1600C     DETERMINE IF BOTH TAPES (1975/1977) HAVE BEEN SCREENED (SEE BELOW)
1610C     AND, IF SO, TRANSFER TO '5 CONTINUE' TO PROCEED WITH THE ANALYSIS
1620C
1630 IF(IFC1.EQ.13.AND.IFC2.EQ.14)GO TO 5
1640C
1650C     AFTER THE FIRST DATA TAPE (1975) HAS BEEN SCREENED, REPLACE READ &
1660C     WRITE FILE/DEVICE CODES (TO READ FROM 1977 TAPE AND WRITE TO A NEW
1670C     SCRATCH-FILE) AND RETURN TO '1 CONTINUE' TO PROCESS SECOND TAPE
1680C
1690 IFC1=13
1700 IFC2=14
1710 GO TO 1
1720C
1730 5 CONTINUE
1740C
1750C     AT THIS POINT, THE DATA TAPES FOR BOTH YEARS HAVE BEEN SCREENED;
1760C     THE READ & WRITE FILE/DEVICE CODES IFC1 & IFC2 ARE RETURNED TO THE
1770C     INITIAL STATES (INDICATING THAT 1975 DATA WILL BE PROCESSED FIRST)
1780C     AND A NEW SCRATCH-FILE (IFC3) IS INITIALIZED (TO RETAIN THE DATA
1790C     THAT HAS MET THE CRITERIA OF SEASONALITY AS ESTABLISHED BELOW)
1800C
1810 IFC1=11
1820 IFC2=12
1830 IFC3=15
1840C
1850 6 CONTINUE
1860C
1870 READ(IFC2,7,END=13)IDBASE,IFSC,AATO,AIIN,ISCL,IHBD,(N(I),I=1,12)
1880 7 FORMAT(I5,I5,A3,A8,I7,I5,12I8)
1890C
1900C     FOR EACH ITEM IN THE FILE, TOTAL THE ANNUAL DEMAND FOR THE ITEM
1910C
1920 DO 8 I=1,12
1930 8 TOT=TOT+FLOAT(N(I))
1940C
1950C     DIVIDE TOTAL ANNUAL DEMAND BY TWELVE TO FIND MEAN ANNUAL DEMAND
1960C
1970 AVG=TOT/12.0
1980 TOT=0.0
1990C
2000C     IF THE MEAN DEMAND FOR THE ITEM IS ZERO, EXCLUDE THIS RECORD
2010C
2020 IF(AVG.LE.0.0)GO TO 6
2030C
2040C     DETERMINE THE MEAN DEMAND FOR EACH POSSIBLE THREE-CONSECUTIVE-
2050C     MONTH PERIOD THROUGHOUT THE YEAR (JAN-FEB-MAR; FEB-MAR-APR; etc)
2060C
2070 DO 9 I=1,10
```

```
2080 9 B(I)=FLOAT(N(I)+N(I+1)+N(I+2))/3.0
2090 B(11)=FLOAT(N(11)+N(12)+N(1))/3.0
2100 B(12)=FLOAT(N(12)+N(1)+N(2))/3.0
2110C
2120C     TO FIND THE STANDARD-DEVIATION OF THE DATA, FIND (AND SQUARE) THE
2130C     INDIVIDUAL MONTHLY DEVIATIONS FROM THE MEAN (PREVIOUSLY COMPUTED),
2140C     SUM THESE SQUARED DEVIATIONS, AND DIVIDE BY 'N-1', OR ELEVEN, TO
2150C     DETERMINE THE VARIANCE;  THEN TAKE THE SQUARE-ROOT OF THE VARIANCE
2160C     TO ARRIVE AT THE STANDARD-DEVIATION OF DEMAND FOR EACH ITEM
2170C
2180 DO 10 I=1,12
2190 C(I)=(FLOAT(N(I))-AVG)**2
2200 10 VAR=VAR+C(I)
2210 VAR=VAR/11.0
2220 STD=SQRT(VAR)
2230 VAR=0.0
2240C
2250C     DEVELOP A CONFIDENCE-INTERVAL AROUND THE MEAN BY ADDING THE VALUE
2260C     OF ONE STANDARD-DEVIATION UNIT TO THE MEAN (UPPER LIMIT) AND ALSO
2270C     SUBTRACTING ONE STANDARD-DEVIATION UNIT TO THE MEAN (LOWER LIMIT)
2280C
2290 T1=AVG+(1.00*STD)
2300 T2=AVG-(1.00*STD)
2310C
2320C     DETERMINE WHETHER ANY OF THE ABOVE CALCULATED THREE-MONTH AVERAGE
2330C     VALUES LIE OUTSIDE THE CONFIDENCE REGION;  IF NOT, RETURN TO THE
2340C     STATEMENT '6 CONTINUE' AND READ THE NEXT RECORD;  IF SO, GO TO THE
2350C     STATEMENT '12 CONTINUE' WHERE THIS RECORD WILL BE COUNTED AND THEN
2360C     WRITTEN ONTO THE SCRATCH-FILE (IFC3) FOR FURTHER ANALYSIS
2370C
2380 DO 11 I=1,12
2390 IF(B(I).GT.T1.OR.B(I).LT.T2)GO TO 12
2400 11 CONTINUE
2410 GO TO 6
2420C
2430 12 CONTINUE
2440C
2450 NSR(IFC1)=NSR(IFC1)+1
2460 WRITE(IFC3,7)IDBASE,IFSC,AATO,AIIN,ISCL,IHBD,(N(I),I=1,12)
2470C
2480C     RETURN TO '6 CONTINUE' TO READ THE NEXT RECORD
2490C
2500 GO TO 6
2510C
2520C     WHEN THE END-OF-FILE FOR THE INITIAL SCRATCH-FILE IS ENCOUNTERED,
2530C     REWIND THE NEWLY CREATED SCRATCH-FILE (IFC3) CONTAINING SEASONAL
2540C     RECORDS TO ALLOW THIS FILE TO BE READ LATER IN THE PROGRAM
2550C
2560 13 REWIND IFC3
2570C
2580C     WRITE OUT THE TOTALS (FOR EACH YEAR) THAT HAVE BEEN ACCUMULATED
2590C
2600 IF(IFC1.EQ.11)WRITE(IFC8,14)NTR(11),IDBASE,NCR(11),NSR(11)
2610 IF(IFC1.EQ.13)WRITE(IFC8,15)NTR(13),IDBASE,NCR(13),NSR(13)
```

```
2620 14 FORMAT(1X,"THERE WERE",I7," TOTAL RECORDS FOR BASE",I5,
2630$" IN 1975, OF WHICH"I5," WERE IN FSC 6505.",//,1X,I6,
2640$" OF THESE RECORDS WERE FOUND TO BE SEASONAL.",/////)
2650 15 FORMAT(1X,"THERE WERE",I7," TOTAL RECORDS FOR BASE",I5,
2660$" IN 1977, OF WHICH",I5," WERE IN FSC 6505.",//,1X,I6,
2670$" OF THESE RECORDS WERE FOUND TO BE SEASONAL.",//////)
2680C
2690C     DETERMINE IF BOTH INITIAL SCRATCH-FILES HAVE BEEN EXAMINED AGAINST
2700C     THE CRITERIA OF SEASONALITY;  IF SO, TRANSFER CONTROL TO STATEMENT
2710C     '16 CONTINUE' TO PROCEED WITH FURTHER ANALYSIS
2720C
2730 IF(IFC1.EQ.13.AND.IFC2.EQ.14)GO TO 16
2740C
2750C     AFTER THE FIRST INITIAL SCRATCH-FILE HAS BEEN EXAMINED FOR THOSE
2760C     RECORDS DETERMINED TO BE SEASONAL, REPLACE FILE/DEVICE CODE AND
2770C     RETURN TO '6 CONTINUE' TO EXAMINE THE 1977 DATA SCRATCH-FILE
2780C
2790 IFC1=13
2800 IFC2=14
2810 IFC3=16
2820C
2830C     RETURN TO '6 CONTINUE' TO READ THE NEXT RECORD
2840C
2850 GO TO 6
2860C
2870 16 CONTINUE
2880C
2890C     AT THIS POINT, THE DATA FOR BOTH YEARS HAS BEEN EXAMINED AND THOSE
2900C     SEASONAL ITEMS FOR 1975 ARE RESIDING ON SCRATCH-FILE FIFTEEN (15)
2910C     & THE 1977 SEASONAL ITEMS ARE ON SCRATCH-FILE SIXTEEN (16);  THE
2920C     TASK NOW IS TO LOOK FOR THOSE STOCK NUMBERS WHICH OCCUR FOR BOTH
2930C     YEARS (ie FIND THOSE NSN'S THAT WERE SEASONAL IN 1975 & 1977)
2940C
2950 READ(15,7,END=99)JA,JB,AATO,AIIN,JE,JF,(N(I),I=1,12)
2960 GO TO 18
2970 17 CONTINUE
2980 READ(16,7,END=99)KA,KB,BATO,BIIN,KE,KF,(N(J),J=1,12)
2990 18 CONTINUE
3000 IF(BIIN.LT.AIIN)GO TO 17
3010 IF(BIIN.GT.AIIN)GO TO 16
3020C
3030C     ONLY THOSE STOCK-NUMBERED ITEMS WHICH WERE SEASONAL FOR BOTH YEARS
3040C     FALL THROUGH THE ABOVE TWO 'IF' STATEMENTS AND ARE NOW COUNTED AND
3050C     PROCEED ON THROUGH THE PROGRAM WHERE VARIOUS FORECASTING METHODS
3060C     WILL BE EMPLOYED & EXAMINED FOR THEIR ABILITY TO RESPOND TO THE
3070C     SEASONAL VARIATIONS PRESENT WITHIN THE DATA
3080C
3090 MATCHS=MATCHS+1
3100C
3110C     THE FIRST FORECASTING METHOD EXAMINED IS THE TWELVE-MONTH MOVING-
3120C     AVERAGE---THE CURRENT METHOD EMPLOYED WITHIN THE U.S. AIR FORCE'S
3130C     MEDICAL MATERIEL MANAGEMENT SYSTEM (MMMS);  THIS METHOD BASICALLY
3140C     PREDICTS NEXT MONTH'S DEMAND AS THE AVERAGE (MEAN) OF THE TWELVE
3150C     PRECEEDING MONTHS DEMAND FOR THE ITEM
```

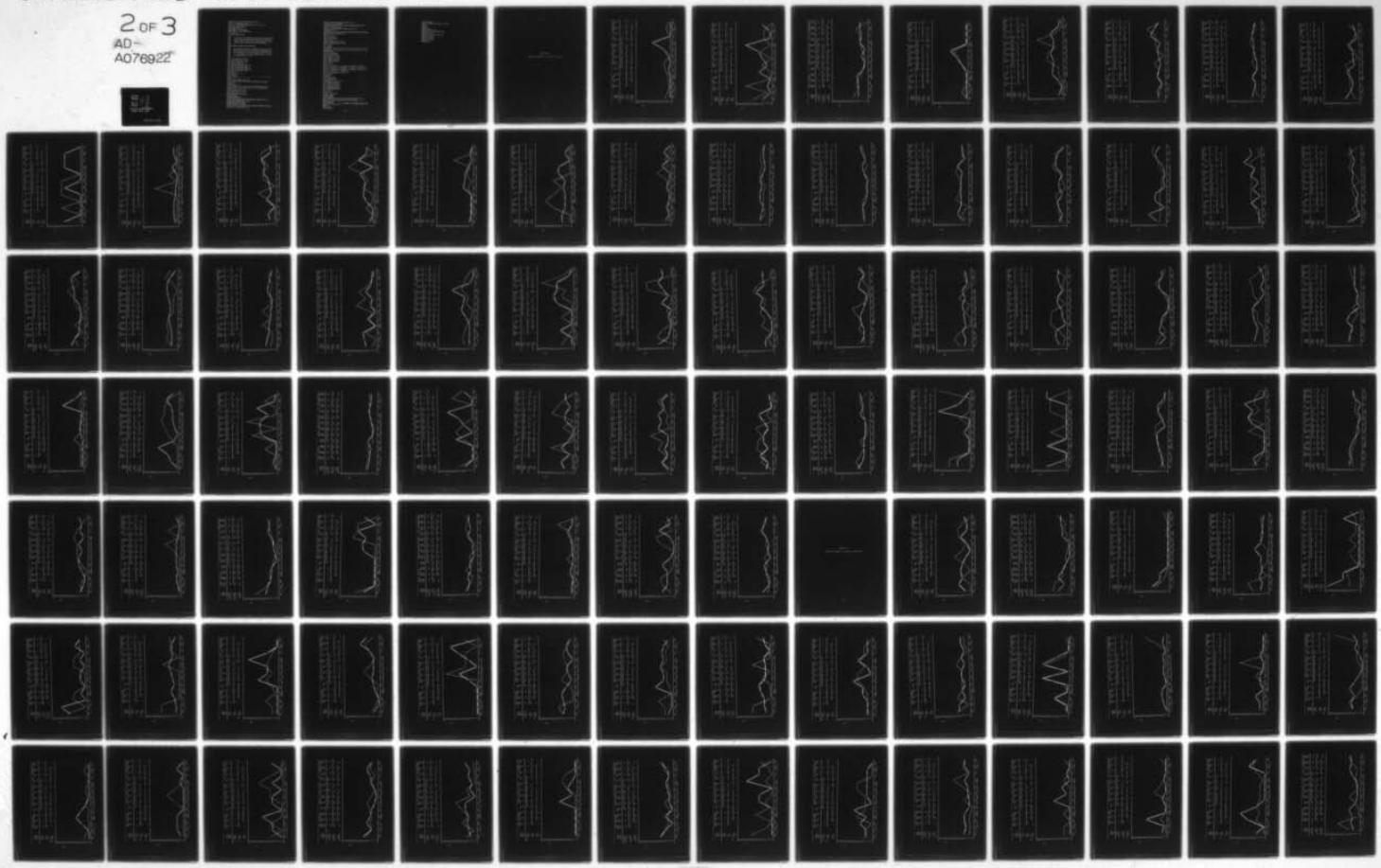
```
3160C
3170C     THE NEXT THREE 'DO-LOOPS' ACCUMULATE THE HISTORICAL DEMAND FOR THE
3180C     ITEM OVER THE PREVIOUS TWELVE-MONTHS CONSUMPTION HISTORY ADVANCING
3190C     ONE MONTH EACH INCREMENT FOR EACH FORECAST PERIOD AND DROPPING THE
3200C     OLDEST (THIRTEENTH MONTH BEHIND) DATA ELEMENT SIMULTANEOUSLY;
3210C     CLOSE ATTENTION IS CALLED TO THE 'DO-LOOP' INDICIES TO ACCOMPLISH
3220C     THIS TWELVE-MONTH FOREWARD-MOVING FORECASTING TECHNIQUE
3230C
3240 ERRMA=0.0
3250 DO 22 I=1,12
3260 EMAV(I)=0.0
3270 DO 19 J=I,12
3280 19 MA(I)=MA(I)+M(J)
3290 IF(I.EQ.1)GO TO 21
3300 L=11-(12-I)
3310 DO 20 K=1,L
3320 20 MA(I)=MA(I)+M(K)
3330 21 MAV(I)=(FLOAT(MA(I))/12.0)+0.5
3340 MA(I)=0
3350C
3360C     THE ACTUAL MONTHLY DEMAND (FOR EACH MONTH OF 1977) IS NOW COMPARED
3370C     WITH THE FORECASTED VALUE FOR THAT MONTH, THE DIFFERENCE BETWEEN
3380C     THE TWO SQUARED, ACCUMULATED, AND DIVIDED BY TWELVE TO ARRIVE AT
3390C     THE 'MEAN-SQUARED-ERROR' OR 'MSE' FOR THE YEAR;  THIS MSE GIVES
3400C     AN INDICATION OF 'GOODNESS-OF-FIT' OF THE FORECASTED VALUE TO
3410C     THE ACTUAL DEMAND ENCOUNTERED FOR EACH RESPECTIVE MONTH
3420C
3430 22 EMAV(I)=EMAV(I)+(FLOAT(MAV(I)-M(I))**2)
3440 DO 23 I=1,12
3450 23 ERRMA=ERRMA+EMAV(I)
3460 ERRMA=ERRMA/12.0
3470 VALUE=0.0
3480 ISAVE=0
3490C
3500C     THE NEXT TWO FORECASTING TECHNIQUES USE A SMOOTHING-CONSTANT KNOWN
3510C     AS ALPHA TO WEIGHT THE VARIOUS FACTORS IN THEIR COMPUTATIONAL EQNS
3520C     THEREFORE, WE GENERATE, AT THIS POINT, NINETEEN VALUES OF ALPHA &
3530C     BETA (1-ALPHA) FROM ALPHA = 0.05 TO ALPHA = 0.95 IN 0.05 INTERVALS
3540C
3550 DO 24 I=1,19
3560 VALUE=VALUE+0.05
3570 ALPHA(I)=VALUE
3580 24 BETA(I)=1.0-ALPHA(I)
3590 AVG3=(FLOAT(M(1)+M(2)+M(3))/3.0)
3600 AMOLD=1000000000.0
3610C
3620C     THE DOUBLE-EXPONENTIAL-SMOOTHING METHOD WILL BE EXAMINED NEXT;
3630C     THE COMPUTATIONS FOR THIS METHOD ARE 'NESTED' WITHIN AN OUTER 'DO-
3640C     LOOP' WHICH ALLOWS THE ENTIRE DOUBLE-EXPONENTIAL-SMOOTHING METHOD
3650C     TO BE REPEATED NINETEEN TIMES---ONCE FOR EACH VALUE OF ALPHA THAT
3660C     WAS PREVIOUSLY GENERATED
3670C
3680 DO 26 I=1,19
3690 ERROR(I)=0.0
```

```
3700C
3710C     THE TEXT OF THIS REPORT EXPOUNDS UPON THE PROCEDURE EMPLOYED BY
3720C     THE DOUBLE-EXPONENTIAL-SMOOTHING METHOD---SUFFICE IT TO SAY HERE
3730C     THAT THE VALUE 'EX' IS THE SINGLE-EXPONENTIALLY-SMOOTHED VALUE
3740C     THAT IS PLACED IN THE 'DX' EQUATION WHERE IT IS SMOOTHED AGAIN;
3750C     THE VALUE 'IX' IS NOTHING MORE THAN AN 'INTEGER-FORMATTED' COPY OF
3760C     THE VALUE 'DX' THAT IS NOT RETAINED UNTIL THE PROGRAM HAS ADVANCED
3770C     ITSELF THROUGH THE 1975 DATA AND IS FORECASTING 1977 DATA, AND IS
3780C     SUBSCRIPTED TO RETAIN THESE VALUES FOR ALL VALUES OF ALPHA USED
3790C
3800 DO 25 J=1,21
3810 IF(J.EQ.1)EX(J)=(ALPHA(I)*FLOAT(M(J+21)))+(BETA(I)*AVG3)
3820 IF(J.EQ.1)DX(J)=(ALPHA(I)*EX(J))+(BETA(I)*AVG3)
3830 IF(J.EQ.1)GO TO 25
3840 IF(J.LE.10)EX(J)=(ALPHA(I)*FLOAT(M(J+2)))+(BETA(I)*EX(J-1))
3850 IF(J.GT.10)EX(J)=(ALPHA(I)*FLOAT(M(J-10)))+(BETA(I)*EX(J-1))
3860 DX(J)=(ALPHA(I)*EX(J))+(BETA(I)*DX(J-1))
3870 IF(J.GT.9)IX(I,J-9)=DX(J)+0.5
3880 IF(J.GT.9)ERROR(I)=ERROR(I)+(FLOAT(IX(I,J-9)-M(J-9))**2)
3890 25 CONTINUE
3900 ERRDX(I)=ERROR(I)/12.0
3910 IF(ERRDX(I).LT.AHOLD)ISAVE=I
3920 IF(ERRDX(I).LT.AHOLD)AHOLD=ERRDX(I)
3930 26 CONTINUE
3940 ALPHOP=0.05*FLOAT(ISAVE)
3950 KSAVE=0
3960 BHOLD=1000000000.0
3970C
3980C     AS OUTLINED IN THE TEXT, THE ADAPTIVE-RESPONSE METHOD IS A FORM OF
3990C     EXPONENTIAL SMOOTHING, THE PRINCIPAL DIFFERENCE BEING THAT THE
4000C     'ALPHA' TERM IS USED MONTHLY TO WEIGHT TWO 'ERROR' TERMS, WHICH
4010C     ARE USED, IN TURN, TO COMPUTE A TRACKING-COEFFICIENT WHICH IS THEN
4020C     USED TO WEIGHT THE FORECASTING EQUATION, AS OPPOSED TO DOING THIS
4030C     WEIGHTING DIRECTLY WITH A FIXED ALPHA;  THIS METHOD, AGAIN, IS
4040C     'NESTED' WITHIN AN OUTER 'DO-LOOP' TO EXAMINE THE METHOD FOR EACH
4050C     AVAILABLE VALUE OF ALPHA;  'IAR' IN THIS METHOD CORRESPONDS TO THE
4060C     VALUE 'IX' USED IN THE DOUBLE-EXPONENTIAL-SMOOTHING METHOD
4070C
4080 DO 100 K=1,19
4090 TRCK=0.5
4100 ERRRR=0.0
4110 ERRAR(K)=0.0
4120 IAR(K,1)=AVG3
4130 DO 27 I=1,24
4140 IF(I.LT.13)IFERRR=M(I)-IAR(K,I)
4150 IF(I.EQ.1)IFERRR=(FLOAT(M(I))*0.1)+1.0
4160 IF(I.GE.13)IFERRR=M(I-12)-IAR(K,I)
4170 IFEROR=IABS(IFERRR)
4180 IF(I.LT.13)IAR(K,I+1)=(TRCK*FLOAT(M(I)))+((1-TRCK)*FLOAT(IAR(K,I)))
4190 IF(I.GE.13)IAR(K,I+1)=(TRCK*FLOAT(M(I-12)))+((1-TRCK)*FLOAT(IAR(K,I)))
4200 IF(I.EQ.1)EWA(I)=(ALPHA(K)*FLOAT(IFERRR))
4210 IF(I.EQ.1)AWD(I)=(ALPHA(K)*FLOAT(IFEROR))
4220 IF(I.EQ.1)GO TO 27
4230 AWD(I)=(ALPHA(K)*FLOAT(IFEROR))+(BETA(K)*AWD(I-1))
```

AD-A076 922 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5
AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MED--ETC(U)
SEP 79 V R GILLOTH , J F OHL, W A WELLS

UNCLASSIFIED AFIT-LSSR-13-79B NL

2 OF 3
AD-
A076922



```
4240 EWA(I)=(ALPHA(K)*FLOAT(IFERRS))+(BETA(K)*EWA(I-1))
4250 IF(I.GT.12)IARSAV(K,I-12)=IAR(K,I)
4260 IF(I.GT.12)ERRRR=ERRRR+(FLOAT(IARSAV(K,I-12)-N(I-12))**2)
4270 27 TRCK=ABS(EWA(I)/AMD(I))
4280 ERRAR(K)=ERRRR/12.0
4290 IF(ERRAR(K).LT.BHOLD)KSAVE=K
4300 IF(ERRAR(K).LT.BHOLD)BHOLD=ERRAR(K)
4310 100 CONTINUE
4320 ALFAOP=0.05*FLOAT(KSAVE)
4330C
4340C     AT THIS POINT, ALL THREE METHODS OF FORECASTING HAVE BEEN EXAMINED
4350C     AND THEIR ASSOCIATED FORECASTING ERROR TERMS (MSE) WILL NOW BE
4360C     COMPARED TO FIND THE MINIMUM ERROR---WHICH CORRESPONDS TO THE MOST
4370C     ACCURATE METHOD OF FORECASTING FOR THAT PARTICULAR DATA
4380C
4390 BEST=AMIN1(ERRMA,ERRDI(ISAVE),ERRAR(KSAVE))
4400C
4410C     THE REMAINDER OF THE PROGRAM IS DEDICATED TO FORMATTING, PRINTING,
4420C     AND PLOTTING THE RESULTS FOR INCLUSION WITHIN THE APPENDICIES OF
4430C     THE FINAL REPORT;  THE PLOTTING PORTION OF THE OUTPUT IS PROVIDED
4440C     TO ALLOW THE READER TO EXAMINE THE DEMAND PATTERNS OF THE ACTUAL
4450C     DATA FOR BOTH YEARS (1975 & 1977)
4460C
4470 IF(JA.EQ.84606)LABEL=" OFFUTT "
4480 IF(JA.EQ.84625)LABEL="WHITEMAN"
4490 IF(BEST.EQ.ERRMA)LABEL1="***"
4500 IF(BEST.NE.ERRMA)LABEL1="   "
4510 IF(BEST.EQ.ERRDI(ISAVE))LABEL2="***"
4520 IF(BEST.NE.ERRDI(ISAVE))LABEL2="   "
4530 IF(BEST.EQ.ERRAR(KSAVE))LABEL3="***"
4540 IF(BEST.NE.ERRAR(KSAVE))LABEL3="   "
4550 WRITE(6,28)
4560 28 FORMAT("1",/////////)
4570 WRITE(IFC0,29)
4580 29 FORMAT(21X,"-------------------------------------------------------
4590&-----------------------------")
4600 WRITE(IFC0,30)LABEL,JB,AATO,AIIN
4610 30 FORMAT(37X,"BASE: ",A6,10X,"MONTHLY DEMAND HISTORY",4X,"NSN: ",
4620&I5,A2,A7)
4630 WRITE(IFC0,31)
4640 31 FORMAT(26X,"YEAR",7X,"JAN",3X,"FEB",3X,"MAR",3X,"APR",3X,"MAY",
4650&3X,"JUN",3X,"JUL",3X,"AUG",3X,"SEP",3X,"OCT",3X,"NOV",3X,"DEC")
4660 WRITE(IFC0,32)(N(I),I=1,12)
4670 32 FORMAT(26X,"1975",4X,12I6)
4680 WRITE(IFC0,33)(N(I),I=1,12)
4690 33 FORMAT(26X,"1977",4X,12I6)
4700 WRITE(IFC0,38)
4710 WRITE(IFC0,34)LABEL1
4720 34 FORMAT(22X,A3,1X,"MSE",28X,"MOVING-AVERAGE FORECAST FOR 1977")
4730 WRITE(IFC0,35)ERRMA,(MAV(I),I=1,12)
4740 35 FORMAT(21X,F9.2,4X,12I6,///)
4750 WRITE(IFC0,36)LABEL2,ALPHOP
4760 36 FORMAT(22X,A3,1X,"MSE",9X,"DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALP
4770&HA =",F6.2,") FORECAST FOR 1977")
```

```
4780 WRITE(IFC0,35)ERRDI(ISAVE),(II(ISAVE,I),I=1,12)
4790 WRITE(IFC0,37)LABEL3,ALFAOP
4800 37 FORMAT(22X,A3,1X,"MSE",14X,"ADAPTIVE-RESPONSE (OPTIMAL ALPHA =",
4810&F6.2,") FORECAST FOR 1977")
4820 WRITE(IFC0,35)ERRAR(KSAVE),(IARSAV(KSAVE,I),I=1,12)
4830 WRITE(IFC0,38)
4840 38 FORMAT(21X,"**********************************************************
4850&**********************************")
4860 DO 39 I=1,12
4870 TOT1A=TOT1A+M(I)
4880 39 TOT2A=TOT2A+N(I)
4890 DO 40 I=1,12
4900 D(I)=100.0*(FLOAT(M(I))/TOT1A)
4910 40 E(I)=100.0*(FLOAT(N(I))/TOT2A)
4920 TOT1A=0.0
4930 TOT2A=0.0
4940 AM=MAX(D(1),D(2),D(3),D(4),D(5),D(6),D(7),D(8),D(9),D(10),D(11),D(12))
4950 AN=MAX(E(1),E(2),E(3),E(4),E(5),E(6),E(7),E(8),E(9),E(10),E(11),E(12))
4960 AO=MAX(AM,AN)
4970 IF(AO.GT.40)ISKALE=1
4980 IF(AO.LE.40)ISKALE=0
4990 IF(ISKALE.EQ.1)CC=105.0
5000 IF(ISKALE.EQ.1)DD=100.0
5010 IF(ISKALE.EQ.0)CC=42.0
5020 IF(ISKALE.EQ.0)DD=40.0
5030 41 CONTINUE
5040 DO 42 I=1,12
5050 IF(D(I).GE.CC.AND.E(I).GE.CC.AND.D(I).LT.DD.AND.E(I).LT.DD)AZ(I)=" "
5060 IF(D(I).GE.DD.AND.E(I).GE.DD.AND.D(I).LT.CC.AND.E(I).LT.CC)AZ(I)="*"
5070 IF(D(I).GE.DD.AND.E(I).GE.DD.AND.D(I).LT.CC.AND.E(I).LT.CC)GO TO 42
5080 IF(D(I).GE.DD.AND.D(I).LT.CC)AZ(I)="I"
5090 IF(E(I).GE.DD.AND.E(I).LT.CC)AZ(I)="O"
5100 42 CONTINUE
5110 IQC=DD
5120 WRITE(IFC0,43)IQC
5130 43 FORMAT(21X,I3)
5140 WRITE(IFC0,44)(AZ(I),I=1,12)
5150 44 FORMAT(1H+,28X,12A7)
5160 IF(ISKALE.EQ.1)CC=CC-5.0
5170 IF(ISKALE.EQ.1)DD=DD-5.0
5180 IF(ISKALE.EQ.0)CC=CC-2.0
5190 IF(ISKALE.EQ.0)DD=DD-2.0
5200 DO 45 I=1,12
5210 45 AZ(I)=" "
5220 IF(CC.GT.0.0)GO TO 41
5230 WRITE(IFC0,38)
5240 WRITE(IFC0,46)
5250 46 FORMAT(26X,"JAN",4X,"FEB",4X,"MAR",4X,"APR",4X,"MAY",4X,"JUN",
5260&4X,"JUL",4X,"AUG",4X,"SEP",4X,"OCT",4X,"NOV",4X,"DEC")
5270 WRITE(IFC0,47)
5280 47 FORMAT(29X,"( I = 1975 )",5X,"PERCENT OF TOTAL ANNUAL DEMAND BY MONT
5290&HS",5X,"( O = 1977 )")
5300 GO TO 16
5310 99 CONTINUE
```

```
5320 WRITE(1FC0,28)
5330 PRINT,"MATCHES FOR BOTH YEARS = ",MATCHS
5340 STOP
5350 END
53600:EXECUTE
53700:LIMITS:40,42K,,10K
53800:TAPE:11,X1D,,71249,,SEA1976-INPUT
53900:FILE:12,X2D,10L
54000:TAPE:13,X3D,,76964,,SEA1978-INPUT
54100:FILE:14,X4D,10L
54200:FILE:15,X5D,10L
54300:FILE:16,X6D,10L
54400:ENDJOB
```

APPENDIX D

COMPUTER PRODUCTS, SEASONAL (OFFUTT)

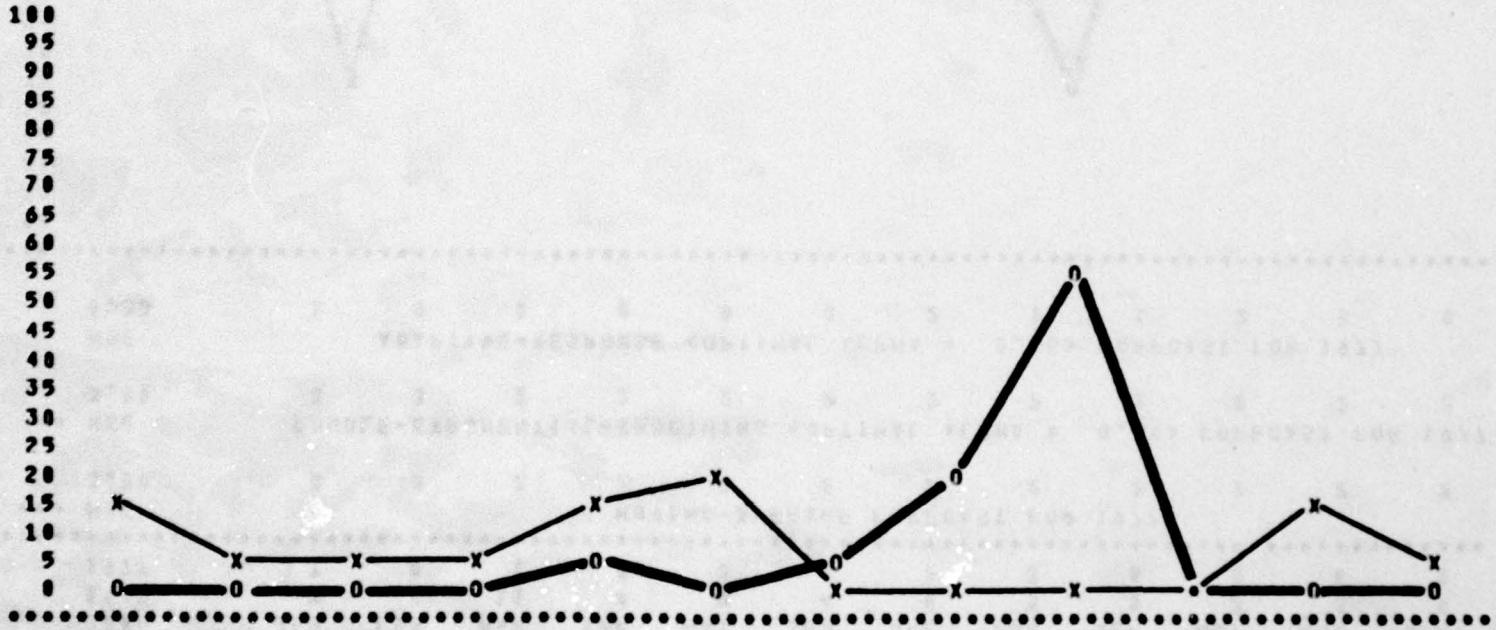
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008592768

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	6	6	4	12	18	0	0	0	0	15	6
1977	0	0	0	1	2	0	2	6	14	0	0	0

MSE					MOVING-AVERAGE FORECAST FOR 1977							
27.00	7	6	5	5	4	4	2	2	3	4	4	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.35) FORECAST FOR 1977											
24.50	6	5	4	3	3	2	2	2	2	4	4	4

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
20.75	3	6	3	1	0	0	0	0	1	5	13	0



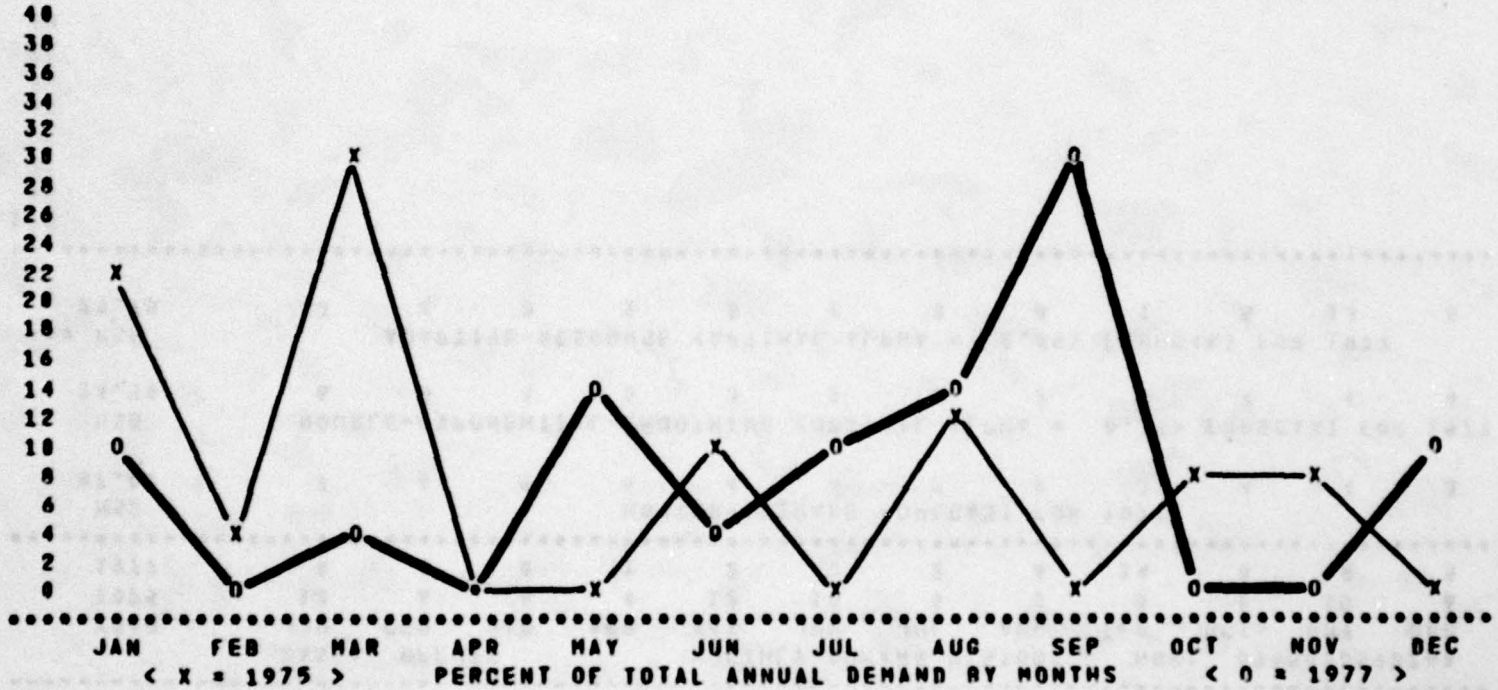
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008797245

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	8	2	11	0	0	4	0	5	0	3	3	0
1977	2	0	1	0	3	1	2	3	6	0	0	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3.50	3	3	2	2	2	2	2	2	2	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
3.50	3	3	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
5.33	1	0	0	0	0	0	2	1	1	2	5	0



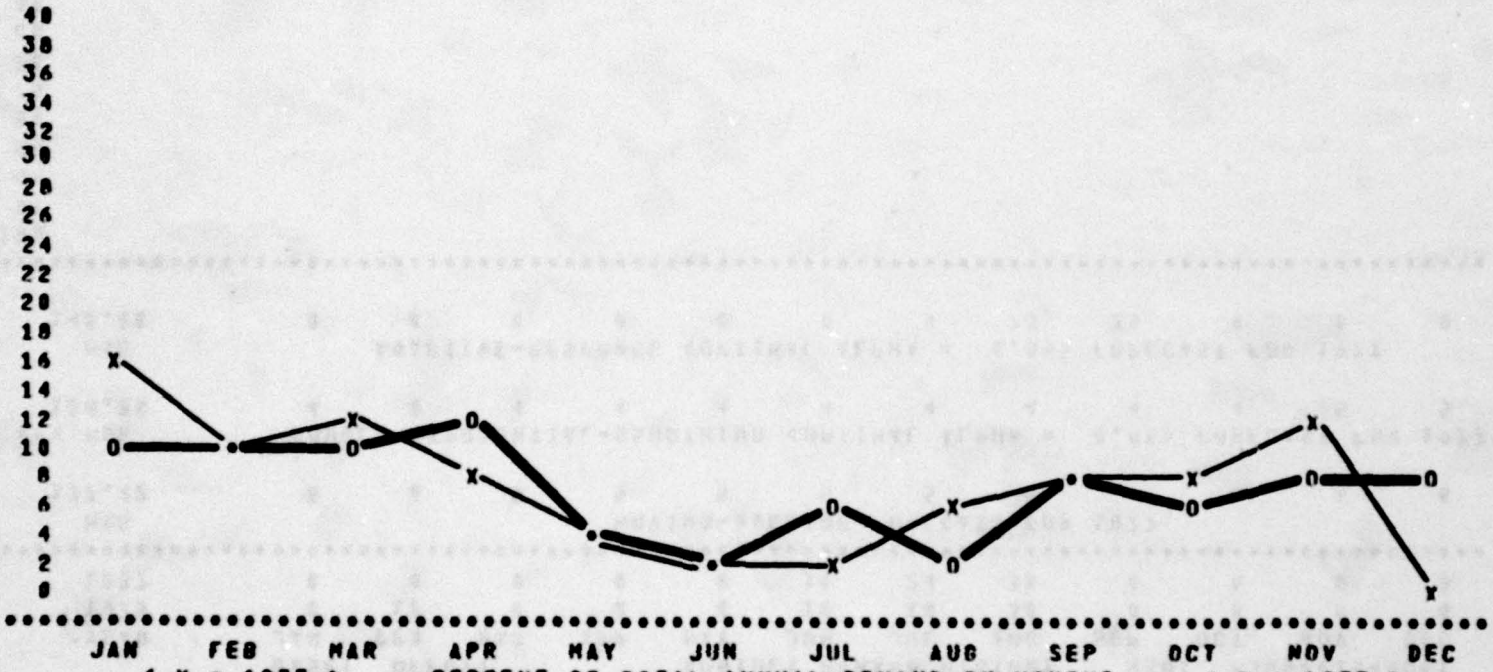
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505000000653

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	228	144	168	132	60	48	48	84	132	132	180	24
1977	192	192	204	228	84	60	108	36	168	109	168	168

MSE					MOVING-AVERAGE FORECAST FOR 1977							
4459.60	115	112	116	119	127	129	130	135	131	134	132	131

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
3481.33	156	154	153	152	152	152	150	149	147	145	143	142

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
3525.50	126	31	121	153	187	219	188	78	98	92	141	128



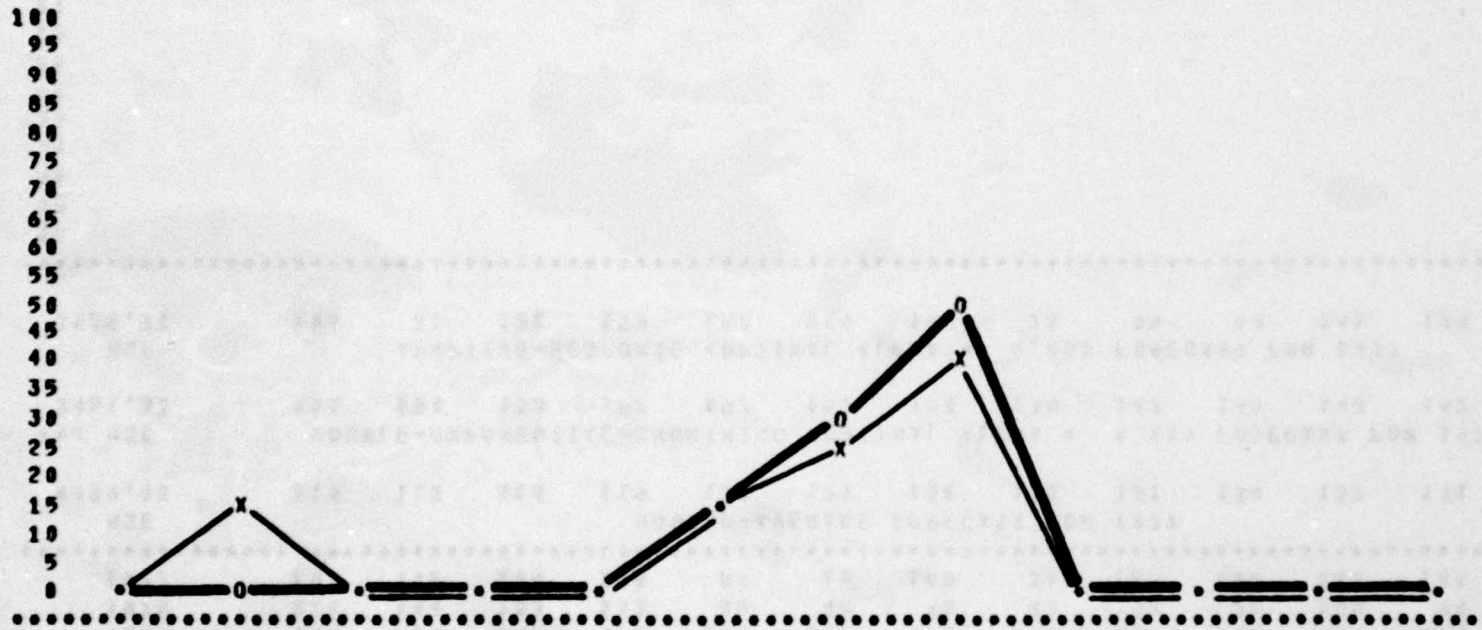
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001048861

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	12	0	0	0	12	18	38	0	0	0	0
1977	0	0	0	0	0	11	24	36	0	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
137.42	6	6	5	5	5	5	5	5	6	6	6	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
136.25	4	4	4	4	4	4	4	4	4	4	5	5

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
145.00	0	0	0	0	0	0	9	23	35	0	0	0



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >

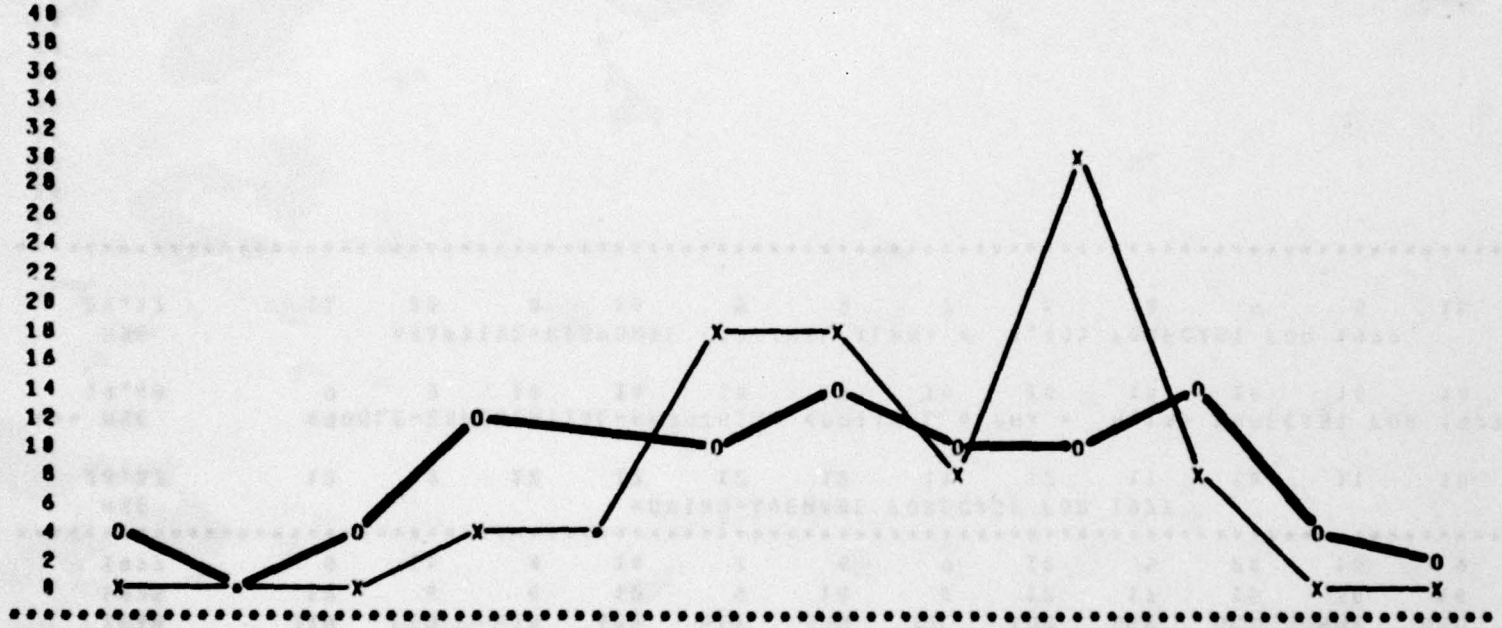
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001182318

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	6	6	24	24	12	36	12	0	0
1977	6	2	7	15	7	12	18	12	12	18	6	4

MSE				MOVING-AVERAGE FORECAST FOR 1977								
27.58	10	11	11	11	12	12	11	11	11	9	9	10

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
28.58	9	9	9	9	9	9	9	9	10	10	11	11

*** MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977											
26.83	3	5	3	5	7	6	11	17	12	11	11	6



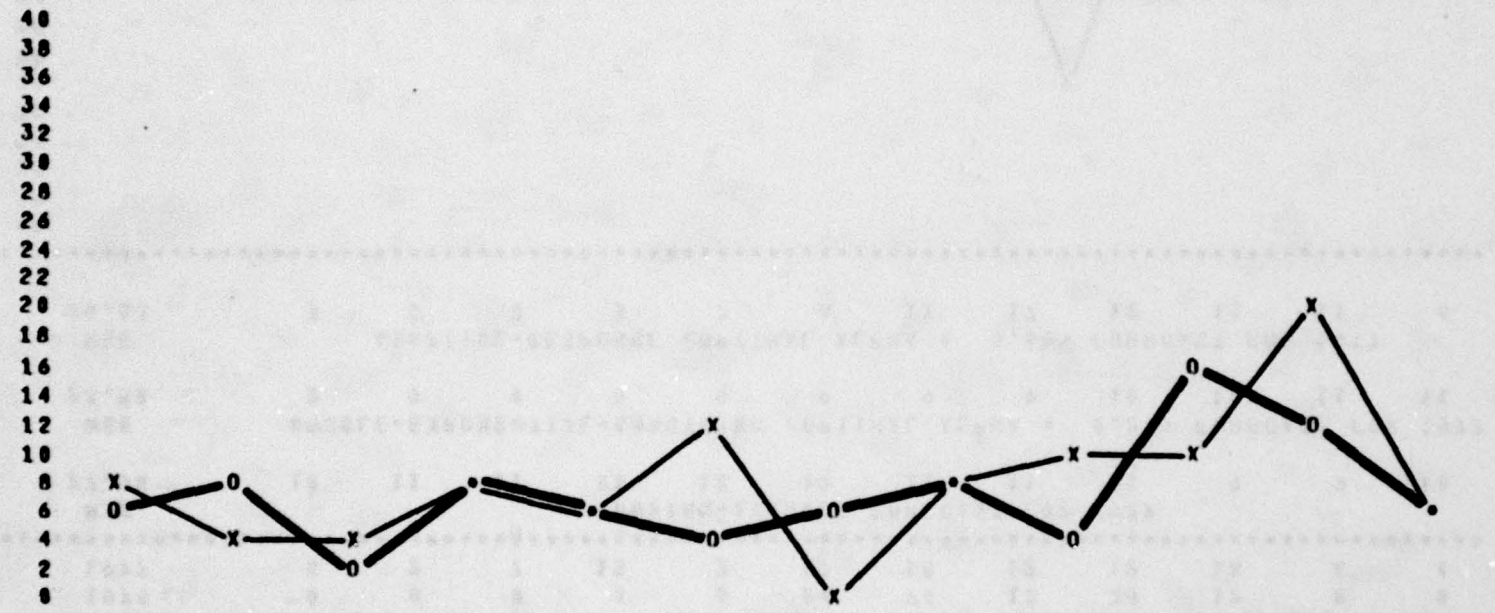
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001342007

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	6	6	12	9	10	0	12	17	15	30	10
1977	8	11	4	10	7	6	9	10	5	20	16	9

MSE	MOVING-AVERAGE FORECAST FOR 1977											
26.33	12	12	12	12	12	12	11	12	11	10	11	10

*** MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
19.88	9	9	10	10	10	10	10	10	10	10	10	10

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
25.17	11	10	8	10	5	9	7	6	8	9	5	10



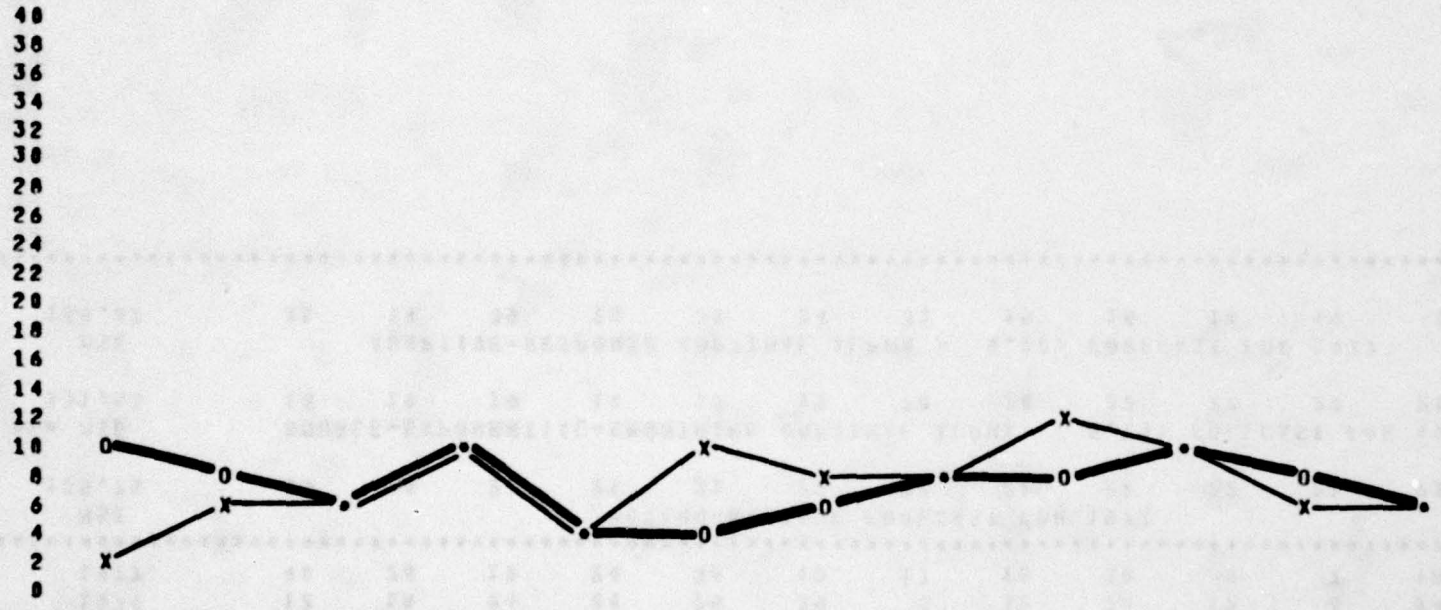
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001352783

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	20	24	36	18	36	30	30	42	36	24	24
1977	31	25	19	31	18	18	20	30	29	36	30	22

MSE					MOVING-AVERAGE FORECAST FOR 1977							
51.33	28	29	30	29	29	29	27	27	27	25	25	26

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
39.88	25	25	26	26	26	26	26	25	25	25	26	26

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
42.75	25	24	29	25	21	30	20	18	19	25	28	35



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

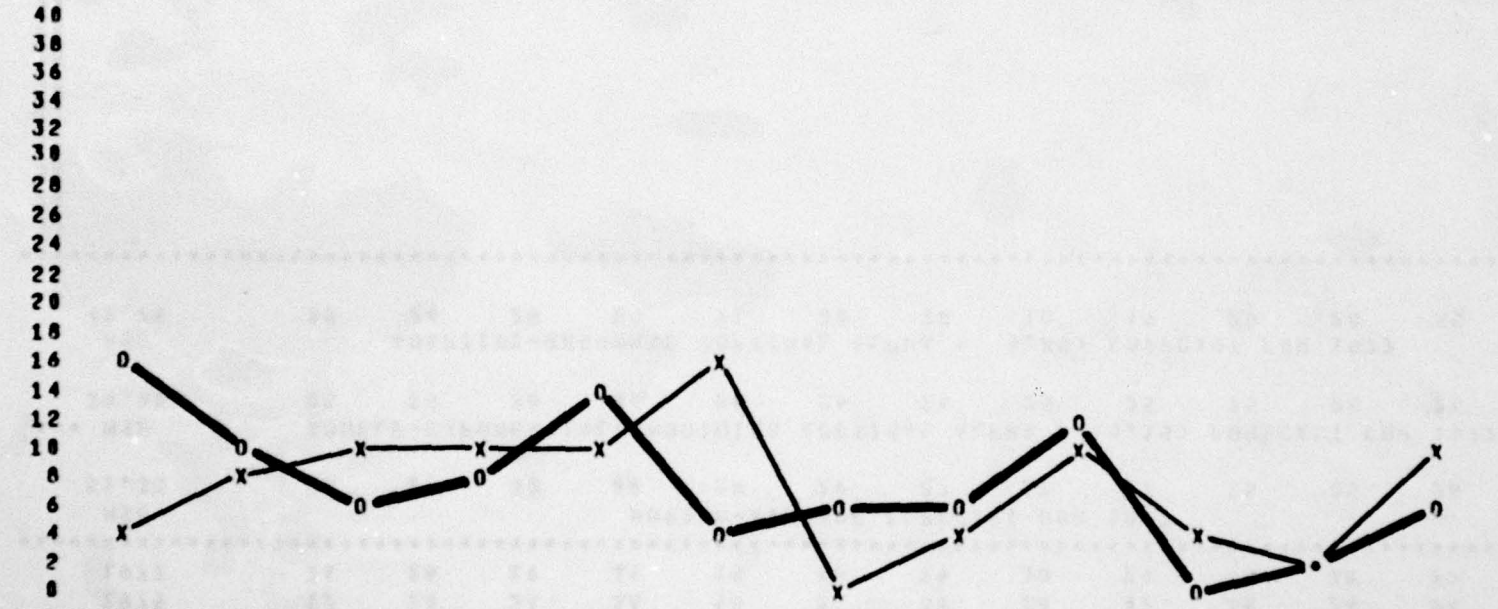
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001376154

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	18	24	24	25	35	0	12	24	12	6	24
1977	40	26	19	24	36	12	17	18	30	0	7	18

MSE	MOVING-AVERAGE FORECAST FOR 1977											
135.75	18	20	21	21	21	22	20	21	22	22	21	21

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
131.83	18	19	19	19	19	19	20	20	20	20	20	20

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
166.67	11	14	35	26	25	24	31	15	16	16	19	1



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

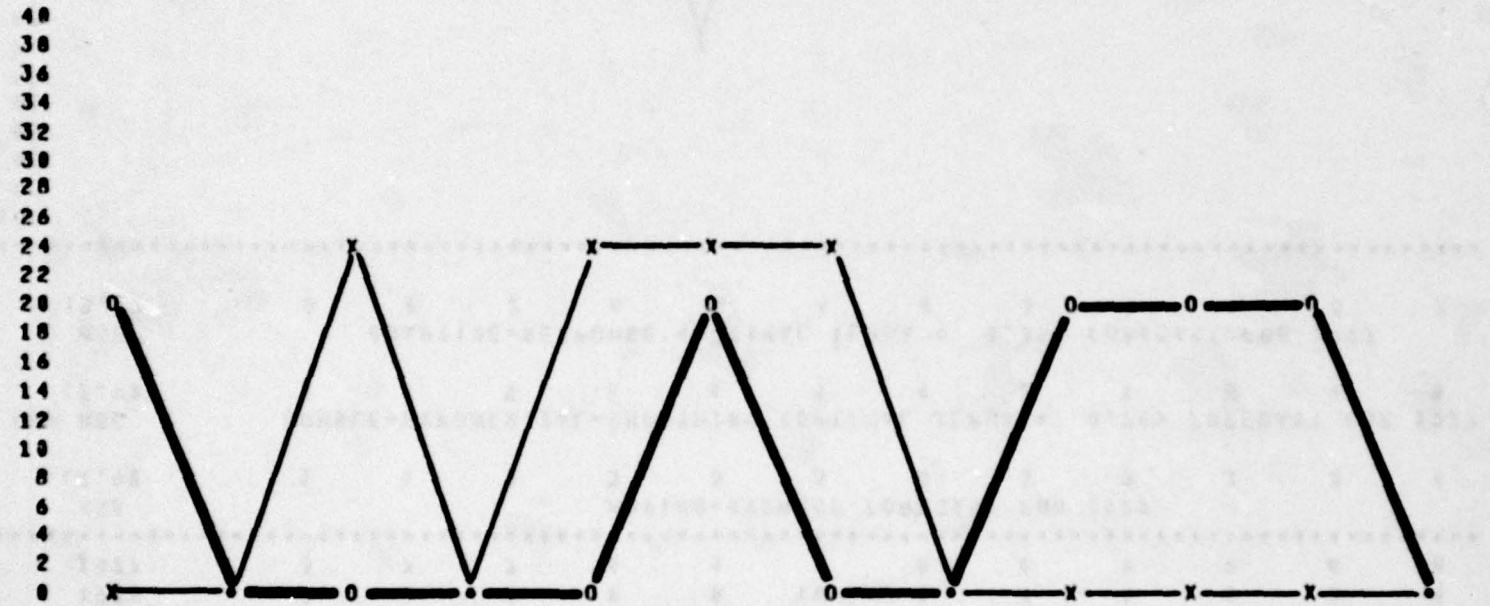
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001483188

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	1	0	1	1	1	0	0	0	0	0
1977	1	0	0	0	0	1	0	0	1	1	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.42	0	0	0	0	0	0	0	0	0	0	0	0

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.70) FORECAST FOR 1977											
0.48	0	0	0	0	0	0	0	0	0	1	1	1

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.85) FORECAST FOR 1977											
0.33	0	0	0	0	0	0	0	0	0	1	1	1



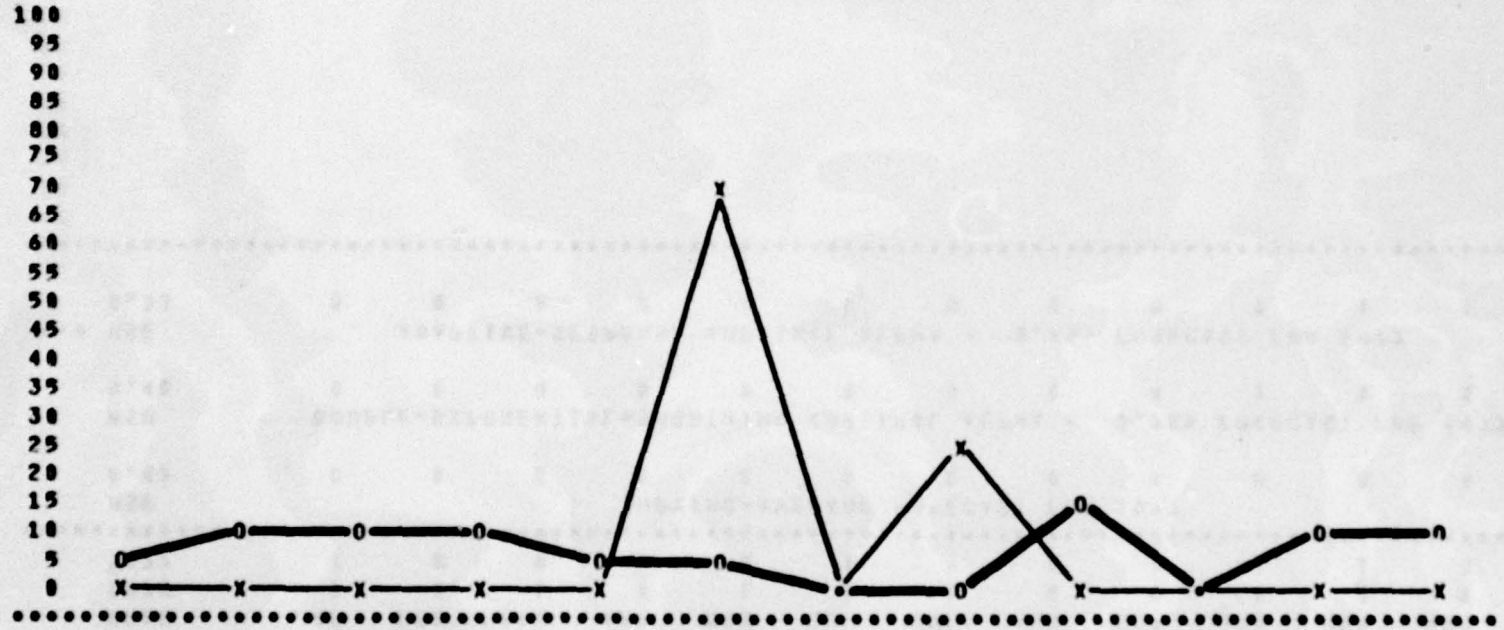
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008555716

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	10	0	4	0	0	0	0
1977	3	7	7	6	4	3	0	0	9	2	6	8

MSE	MOVING-AVERAGE FORECAST FOR 1977											
12.92	1	1	2	3	3	3	3	3	3	3	3	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
12.98	0	2	5	6	6	5	4	2	1	5	4	5

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
15.17	0	0	2	6	6	4	4	3	0	0	0	2

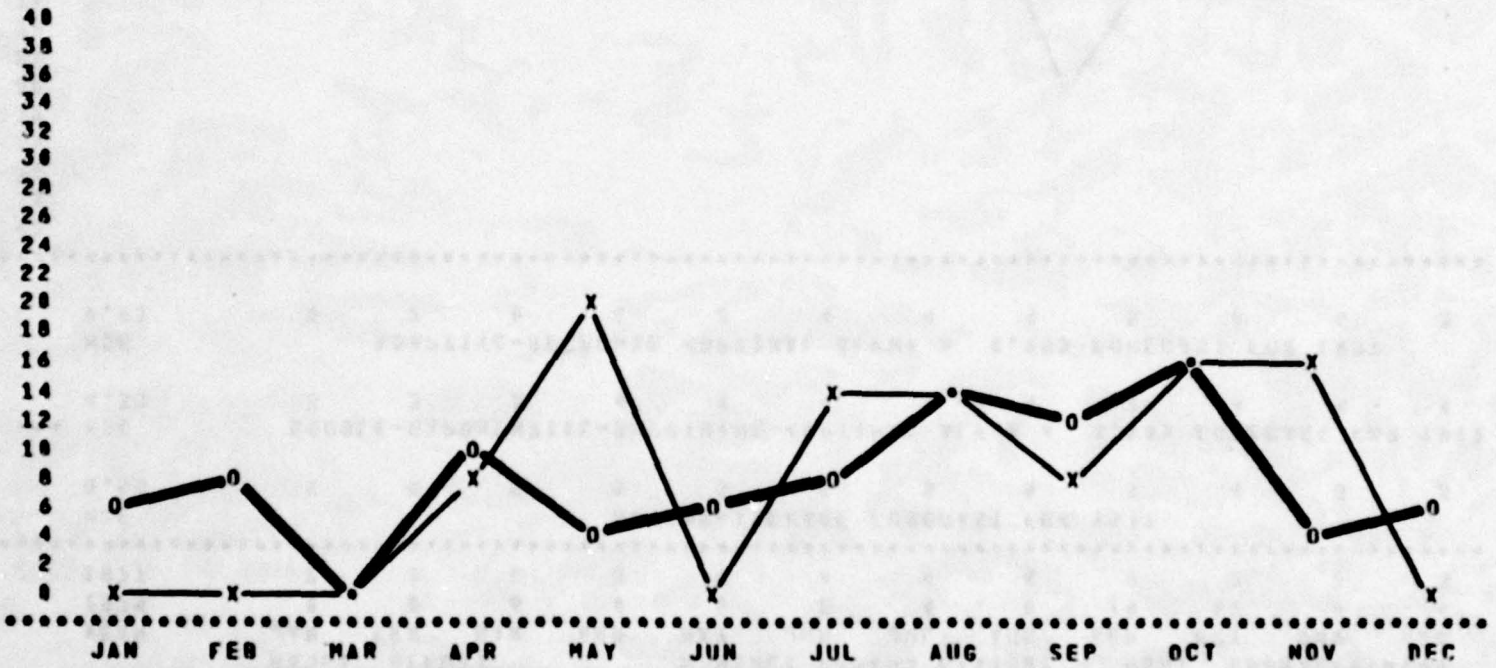


BASE: OFFUTT					MONTHLY DEMAND HISTORY						NSN: 6505001485150	
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	3	7	0	5	5	3	6	6	0
1977	3	4	0	5	2	3	4	7	4	0	2	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
5.25	3	3	4	4	4	3	4	3	4	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.25) FORECAST FOR 1977											
5.17	3	3	3	3	3	3	3	3	3	4	4	4

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
7.42	1	0	1	1	0	0	1	2	3	6	6	7



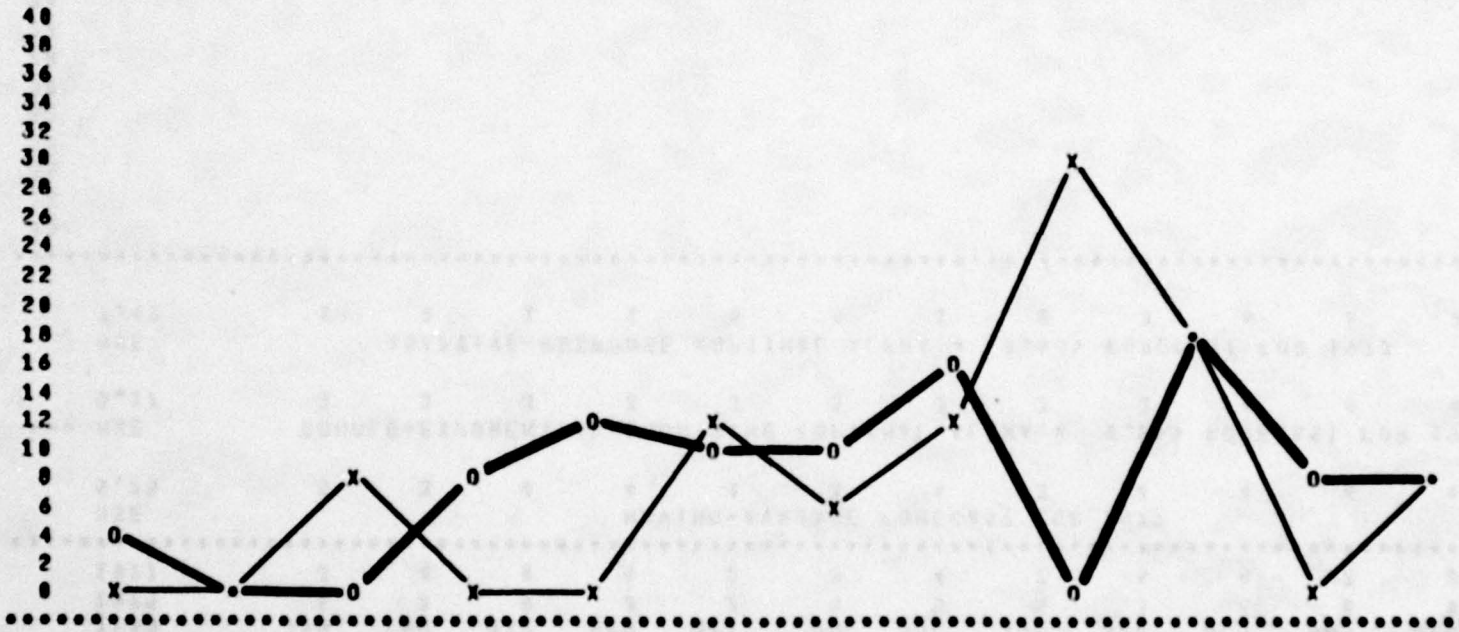
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001490189

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	6	0	0	8	4	8	19	12	0	6
1977	2	0	0	3	5	4	4	6	0	7	3	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
8.58	5	5	5	5	5	6	5	5	5	4	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
4.33	3	3	3	4	4	4	4	4	4	4	4	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
9.83	5	2	0	0	2	4	4	4	5	0	6	3



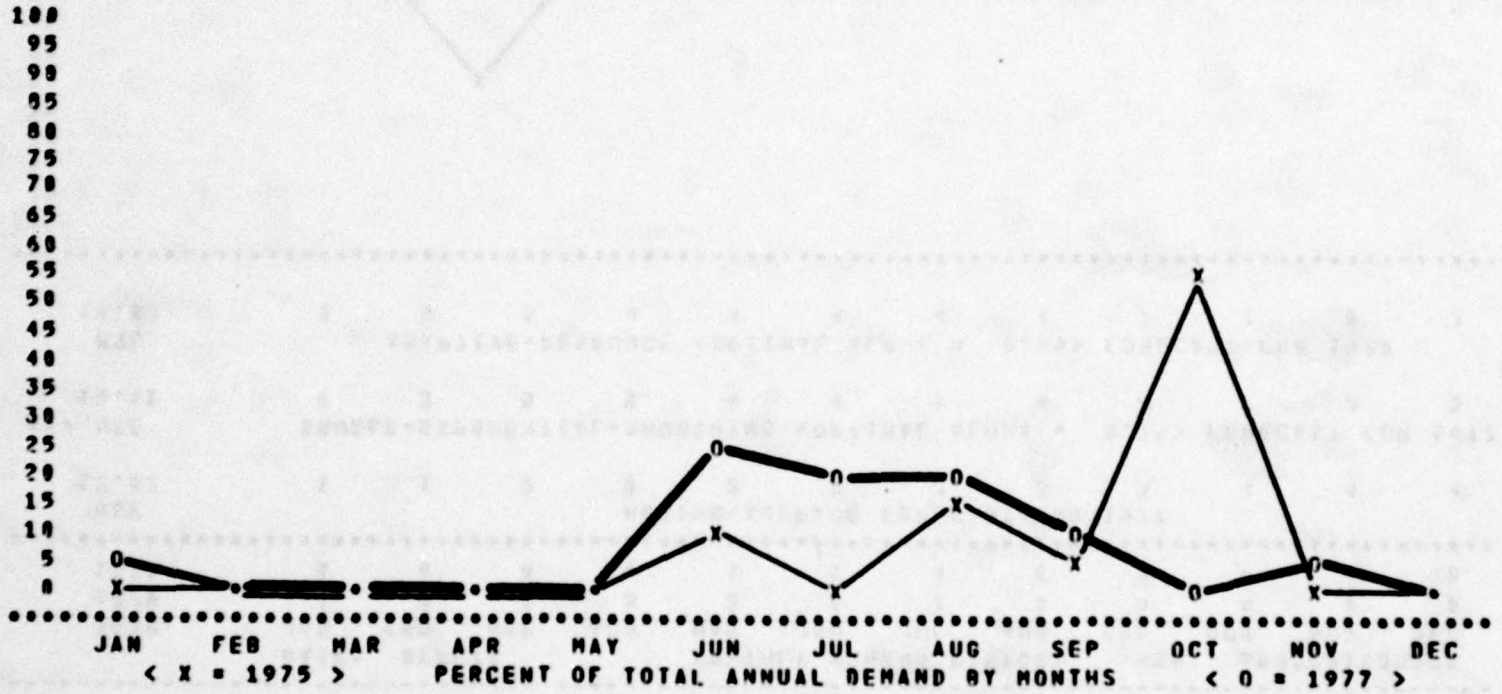
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505801498705

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	3	0	4	2	13	0	0
1977	1	0	0	0	0	4	3	3	2	0	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.33	2	2	2	2	2	2	2	2	2	2	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
2.00	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977											
1.92	0	0	0	0	0	0	3	3	3	2	0	0



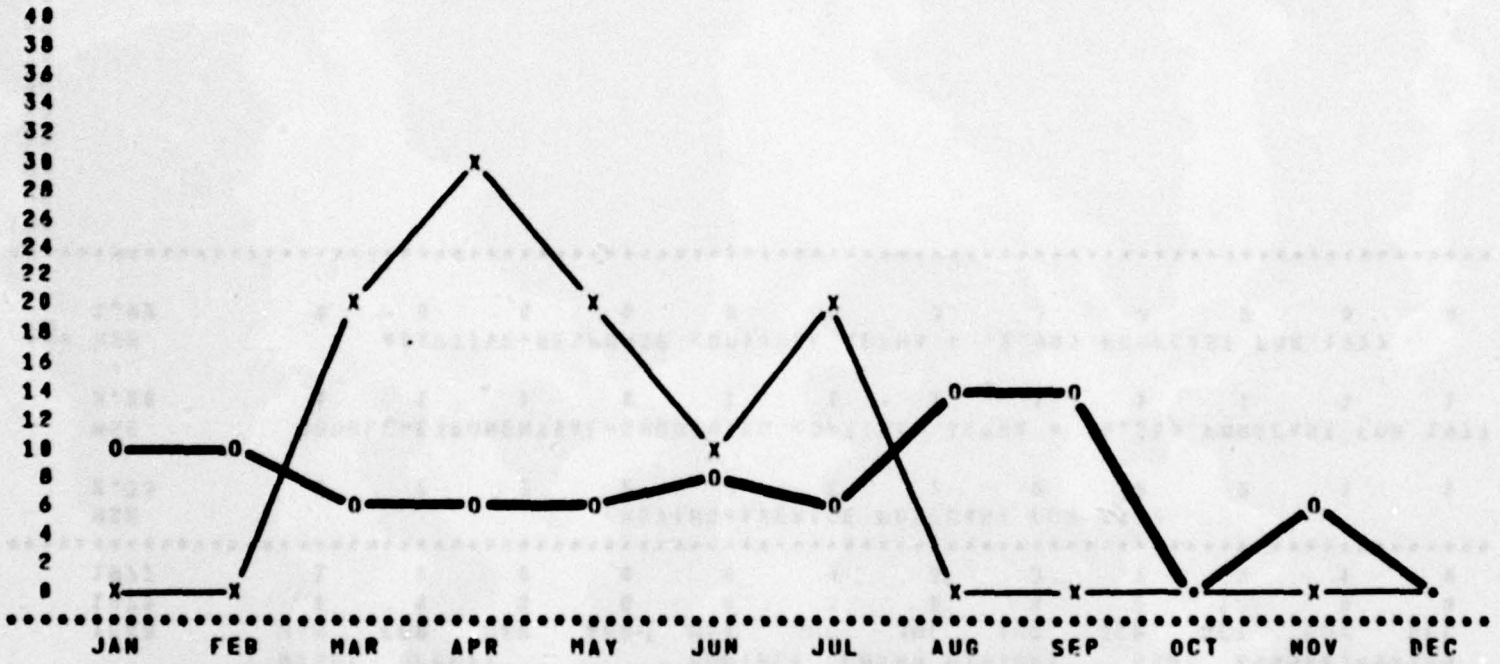
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001538225

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	2	3	2	1	2	0	0	0	0	0
1977	6	6	4	4	4	5	4	8	0	0	4	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
12.83	1	1	2	2	2	2	3	3	3	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.75) FORECAST FOR 1977											
18.81	0	3	5	5	4	4	5	4	6	7	3	3

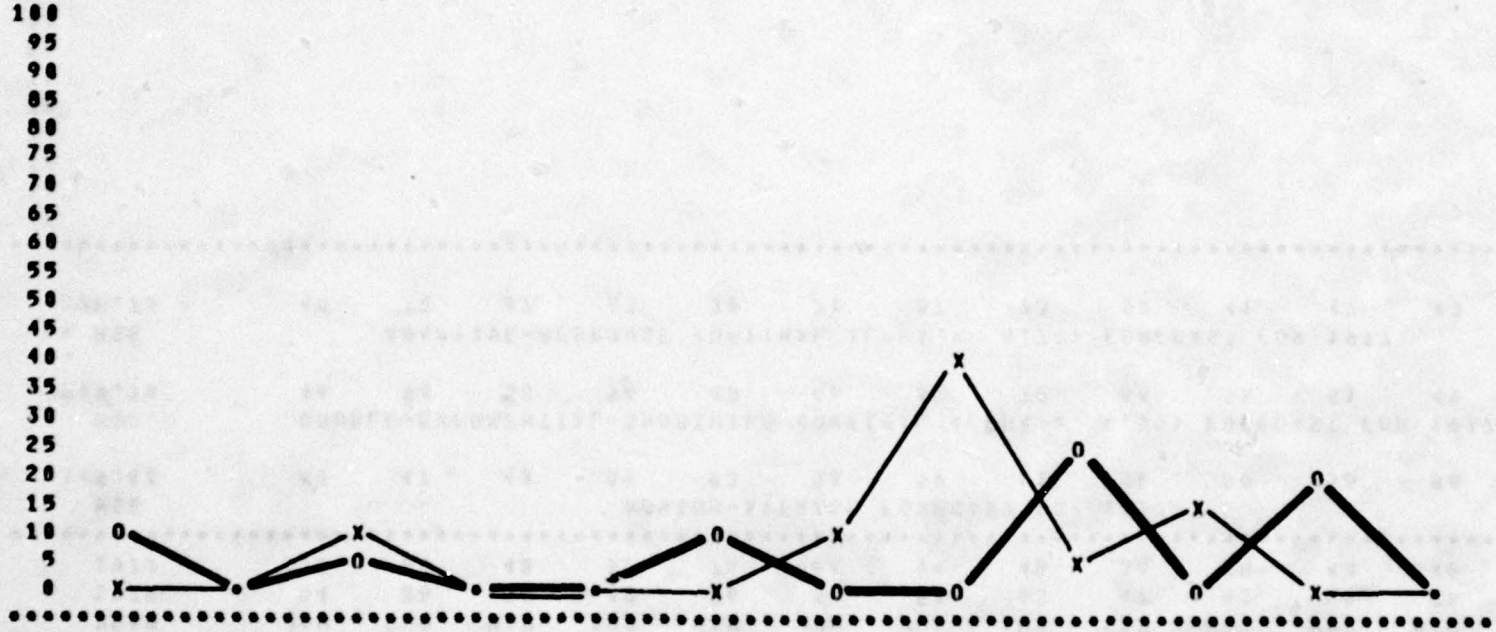
MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.95) FORECAST FOR 1977											
18.83	0	5	5	4	4	4	4	4	7	7	0	3



BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001538278

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	3	0	0	0	3	9	2	4	0	0
1977	0	2	4	0	1	9	1	0	17	3	13	3

MSE												
	MOVING-AVERAGE FORECAST FOR 1977											
32.17	2	2	3	3	3	3	4	3	3	4	4	5
••• MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
31.50	2	3	3	3	3	2	3	3	3	5	6	7
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
43.75	0	0	3	2	2	0	0	2	1	0	2	2



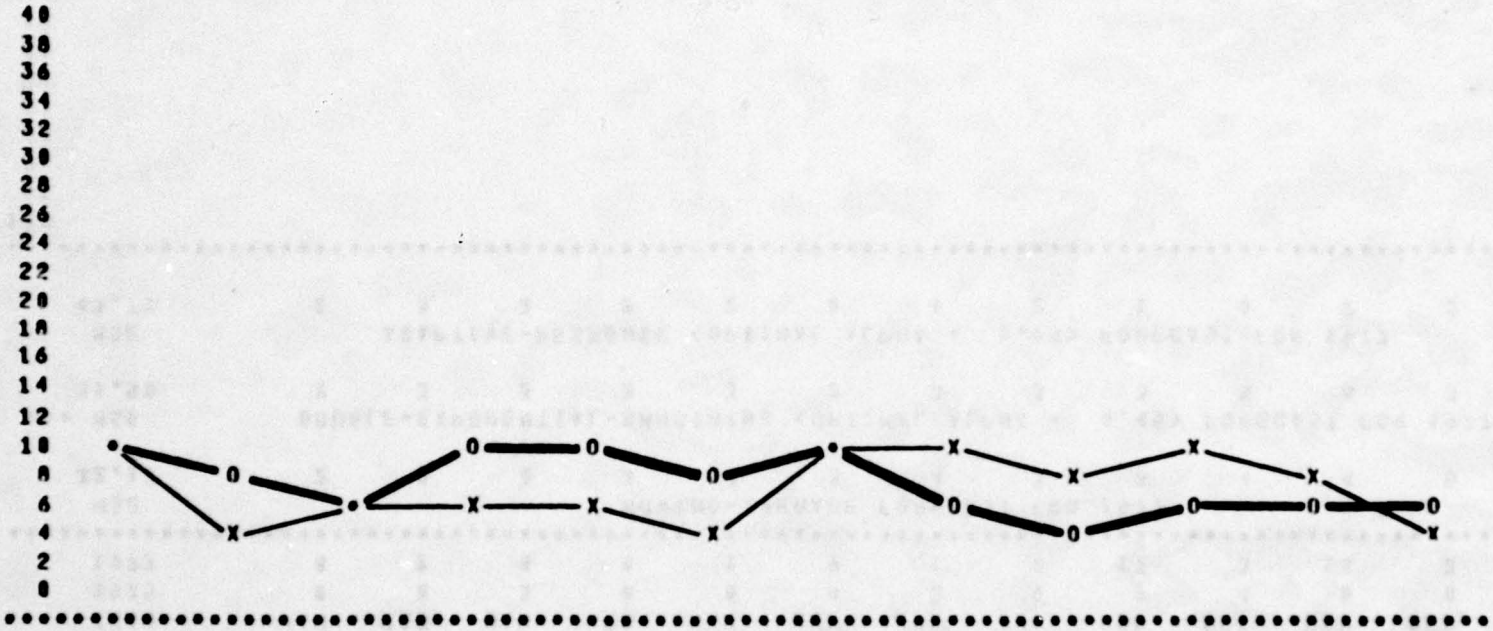
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6585001538488

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	54	30	39	42	36	30	54	63	47	62	50	28
1977	70	63	48	72	76	66	84	48	36	48	48	48

MSE	MOVING-AVERAGE FORECAST FOR 1977											
345.83	45	47	49	50	53	56	59	61	60	59	58	58

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977											
299.70	46	54	58	56	60	66	67	72	66	56	51	49

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
228.75	48	74	67	63	70	71	67	73	52	41	47	47



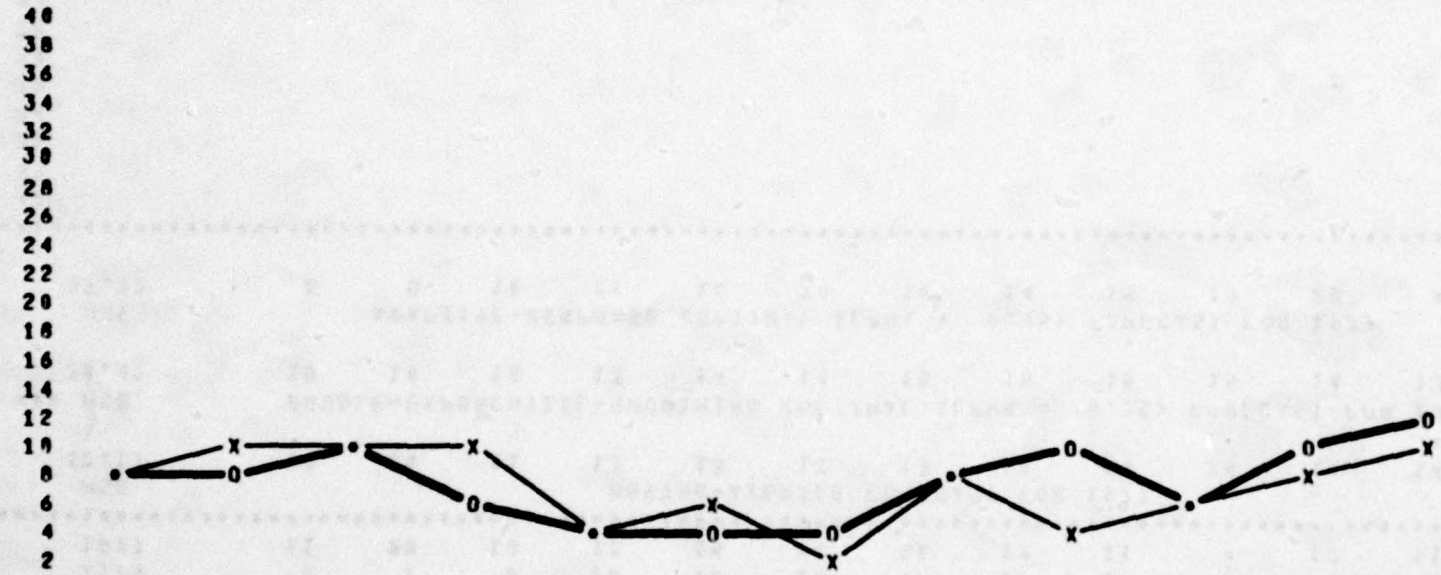
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001538750

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	31	36	34	36	16	23	12	29	14	21	25	35
1977	16	14	18	18	7	8	7	14	18	13	18	20

MSE	MOVING-AVERAGE FORECAST FOR 1977											
67.58	26	25	23	22	19	19	17	17	16	16	15	15

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.75) FORECAST FOR 1977											
48.48	38	22	17	17	13	9	8	8	11	15	14	16

*** MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.45) FORECAST FOR 1977											
26.67	23	34	16	14	17	10	7	7	6	11	17	13



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

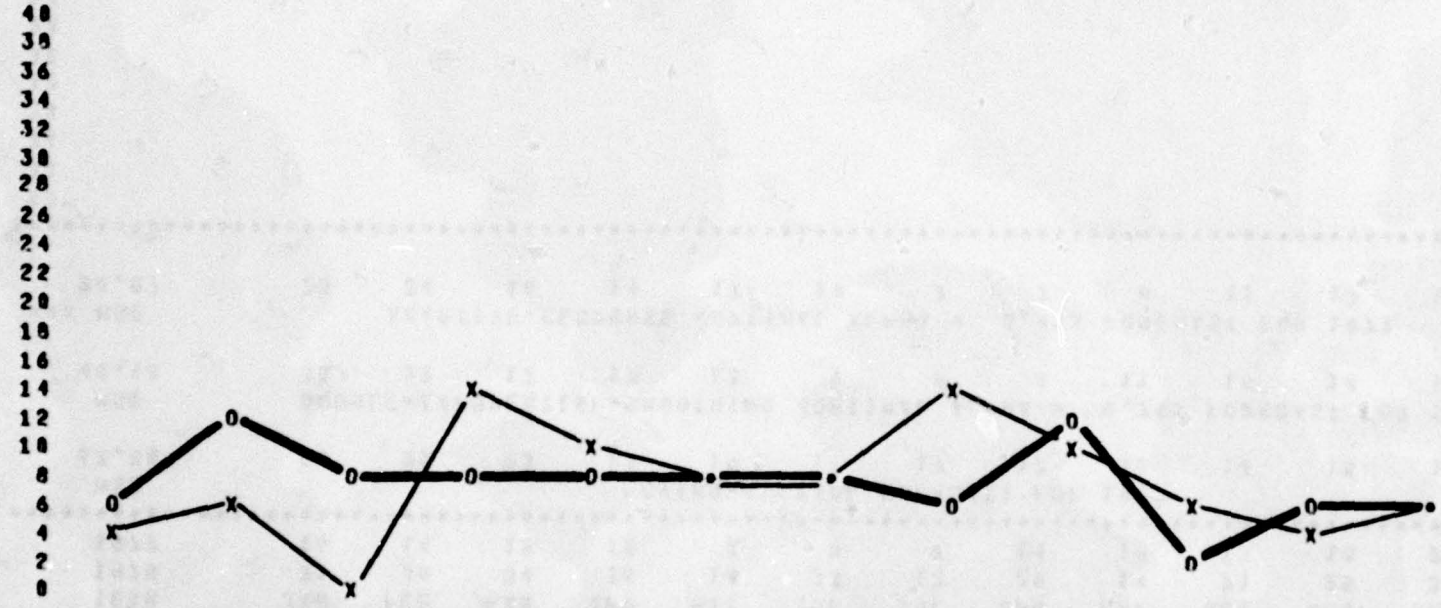
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001596625

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	7	8	18	12	10	10	17	13	8	6	9
1977	11	22	16	17	16	14	16	12	21	4	12	11

MSE	MOVING-AVERAGE FORECAST FOR 1977											
32.17	10	10	11	13	13	13	13	14	13	14	14	14

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
30.42	10	10	11	13	14	14	15	15	15	15	14	13

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
35.92	8	8	10	21	16	16	16	14	15	12	20	4



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

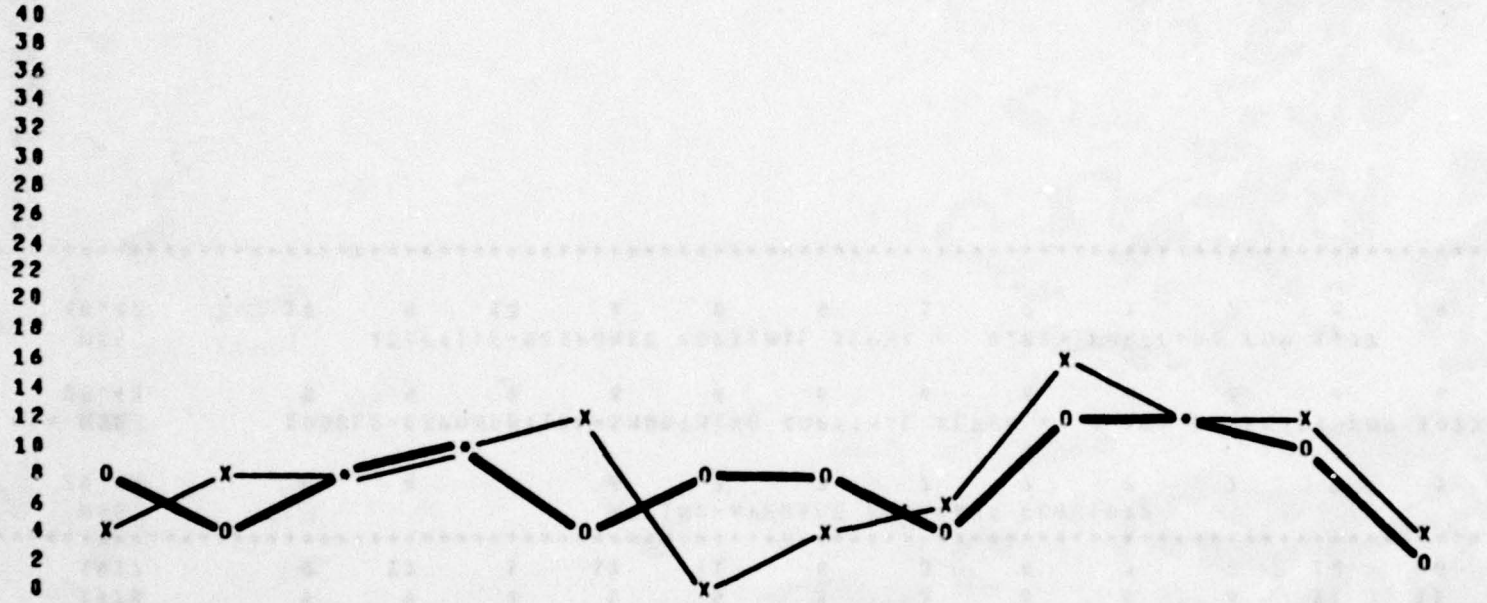
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001806372

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	4	4	5	6	0	2	3	9	6	6	2
1977	3	2	3	4	2	3	3	2	5	5	4	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.88	4	4	4	4	4	3	4	4	4	3	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.42	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
2.33	2	5	3	2	2	3	2	2	2	2	4	4



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

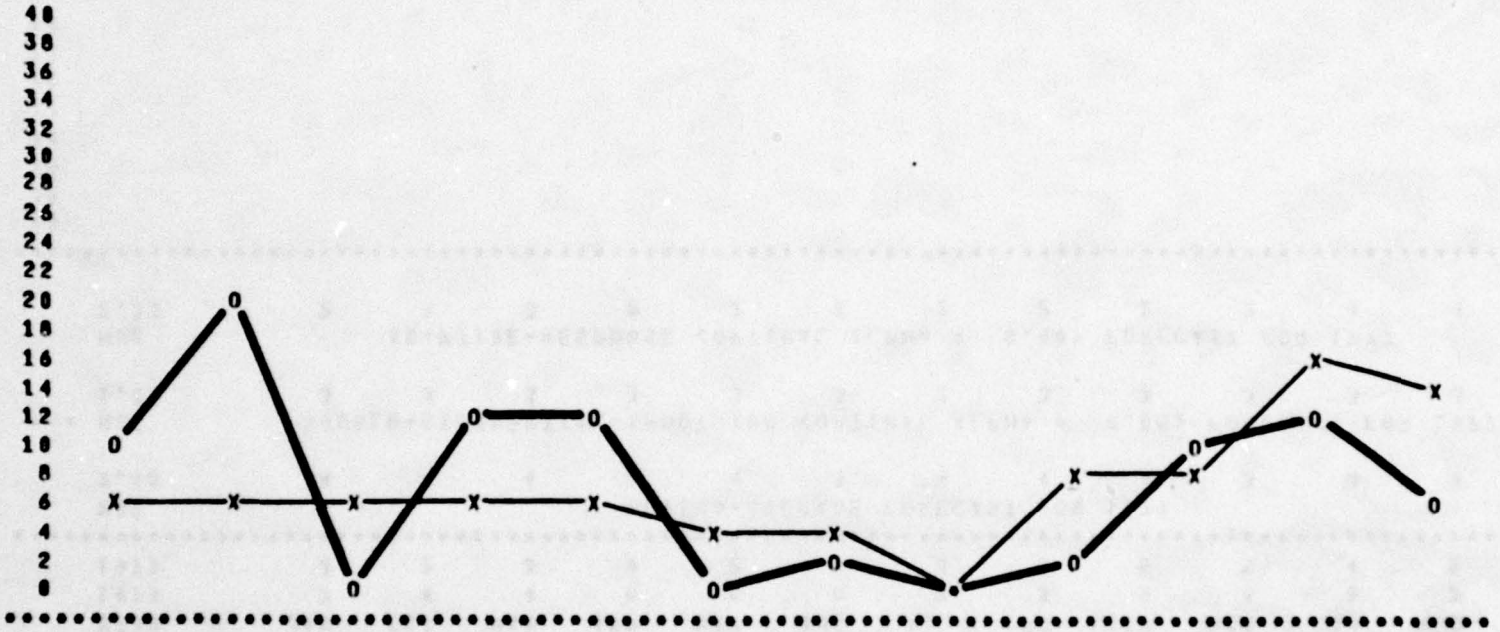
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001817296

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	5	5	4	5	5	3	3	0	6	6	11	10
1977	9	17	1	11	11	0	3	0	3	9	10	6

MSE					MOVING-AVERAGE FORECAST FOR 1977							
29.83	5	6	7	6	7	7	7	7	7	7	7	7

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.15) FORECAST FOR 1977											
28.42	5	5	5	6	6	6	6	6	6	6	6	6

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.80) FORECAST FOR 1977											
40.42	10	9	13	1	8	9	1	2	1	2	6	9



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

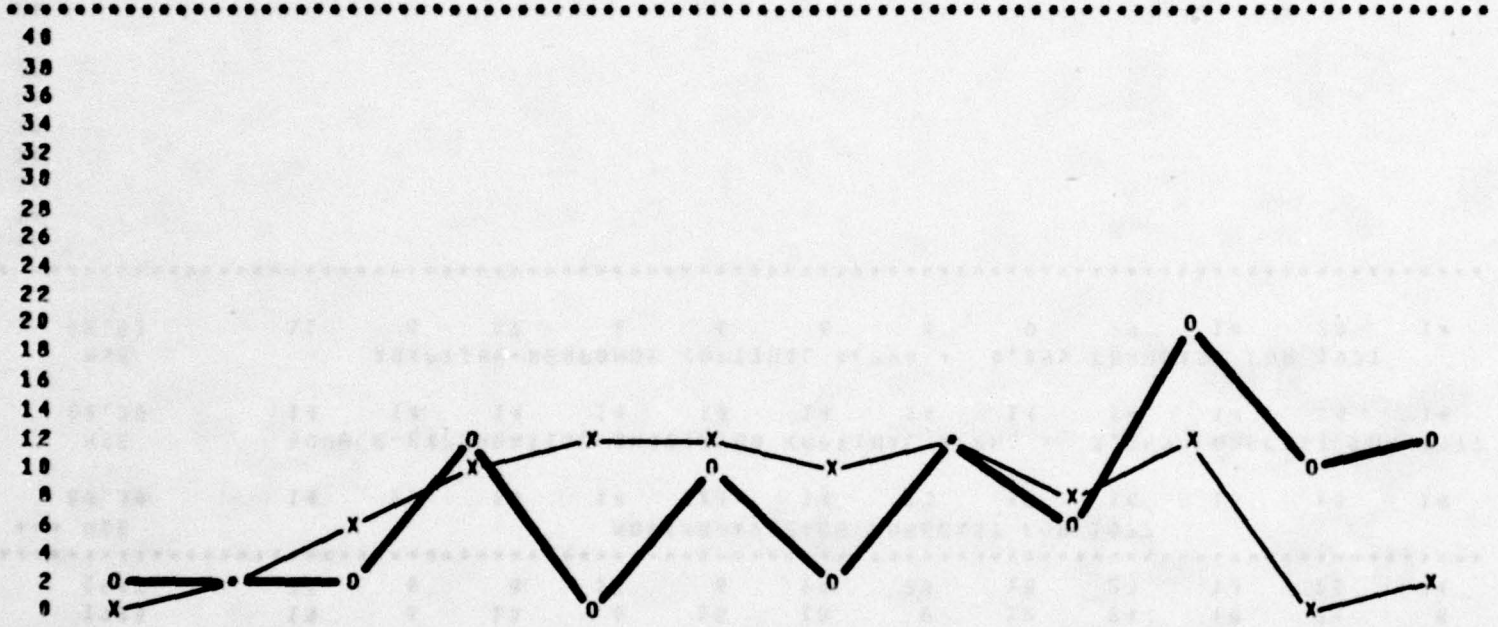
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505002126189

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	12	18	22	21	16	22	14	21	0	6
1977	1	1	1	4	0	3	1	4	2	6	3	4

MSE	MOVING-AVERAGE FORECAST FOR 1977											
59.00	13	13	13	12	11	9	7	6	5	4	2	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
7.75	6	3	2	1	3	1	2	2	3	2	4	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
6.00	5	2	1	1	3	0	2	1	3	2	4	3



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

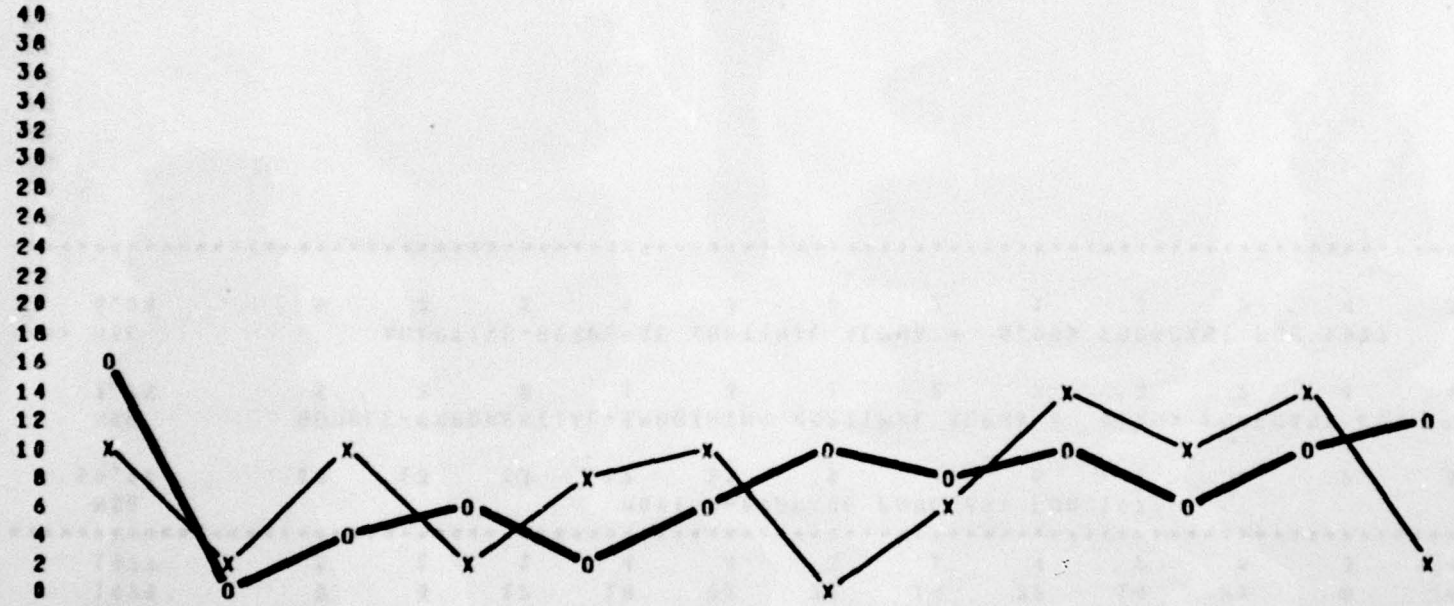
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505002261203

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	18	6	18	6	15	18	2	12	24	18	24	6
1977	33	0	8	13	6	14	22	18	23	13	21	24

MSE	MOVING-AVERAGE FORECAST FOR 1977											
80.00	14	15	15	14	14	14	13	15	16	15	15	15

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
80.75	14	14	14	14	14	14	14	14	14	14	14	14

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
99.83	11	6	17	6	6	6	6	9	20	18	20	14



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

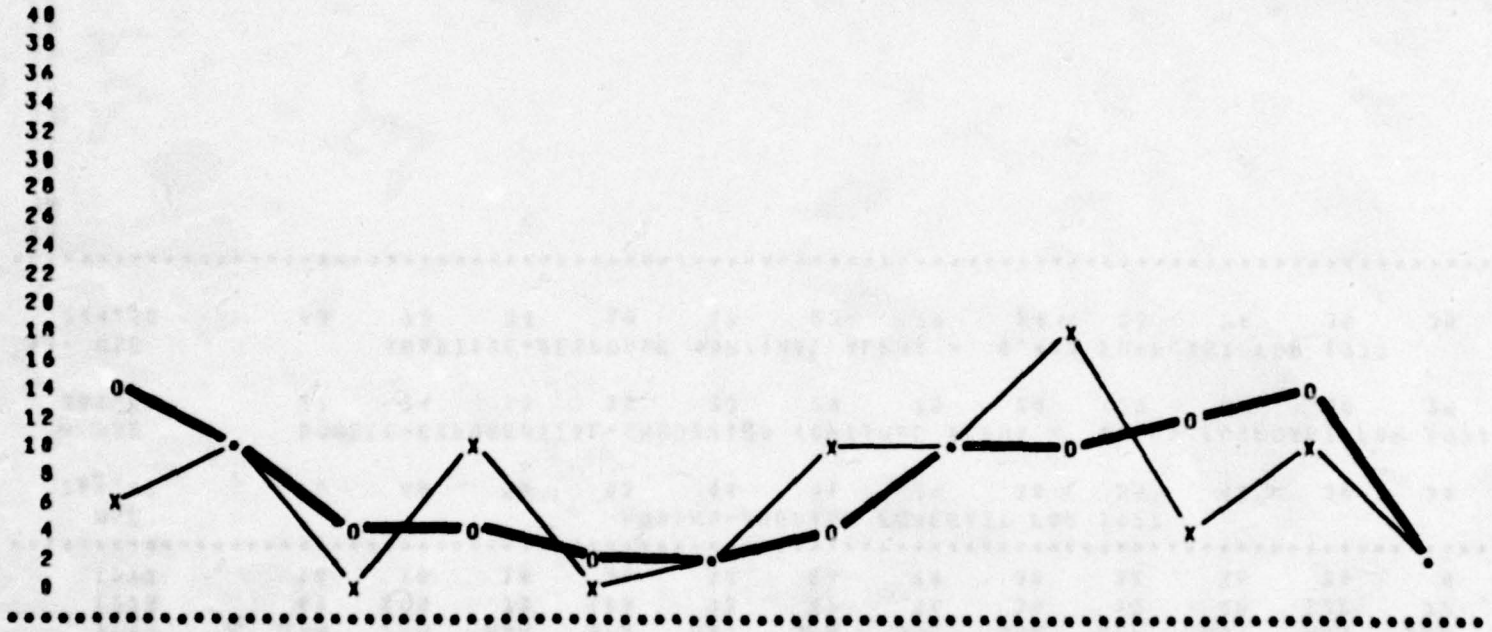
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505002998279

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	24	36	0	36	0	12	36	36	60	18	36	12
1977	60	42	18	24	12	12	24	48	48	54	60	12

MSE	MOVING-AVERAGE FORECAST FOR 1977											
389.67	26	29	29	31	30	31	31	30	31	30	33	35

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.25) FORECAST FOR 1977											
420.17	26	28	30	31	30	29	27	26	27	29	31	34

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.70) FORECAST FOR 1977											
435.17	23	41	41	23	23	17	12	23	38	47	53	59



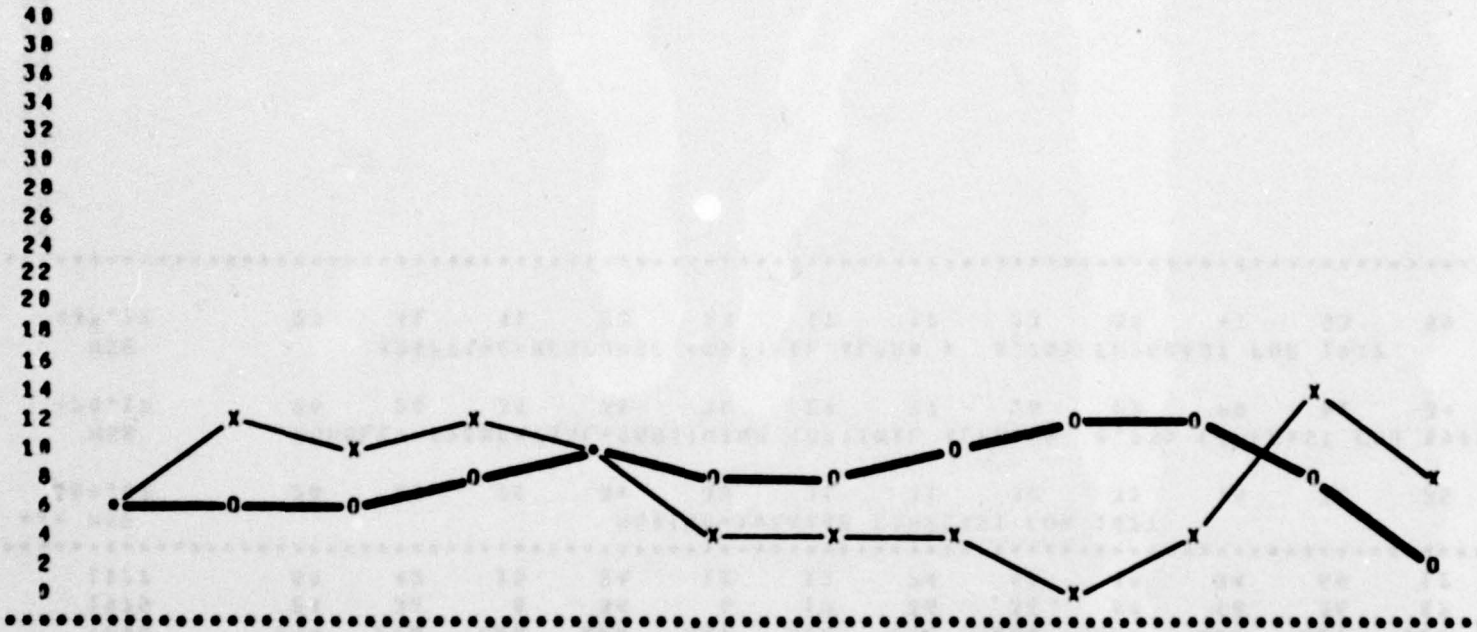
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505002998598

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	60	108	90	108	90	42	36	36	12	48	132	72
1977	18	18	18	24	30	24	24	30	36	36	24	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
765.42	70	66	59	53	46	41	39	30	30	40	39	30

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
361.88	77	24	18	18	23	29	25	24	29	35	36	25

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
244.50	63	72	34	18	17	23	29	24	23	28	35	35



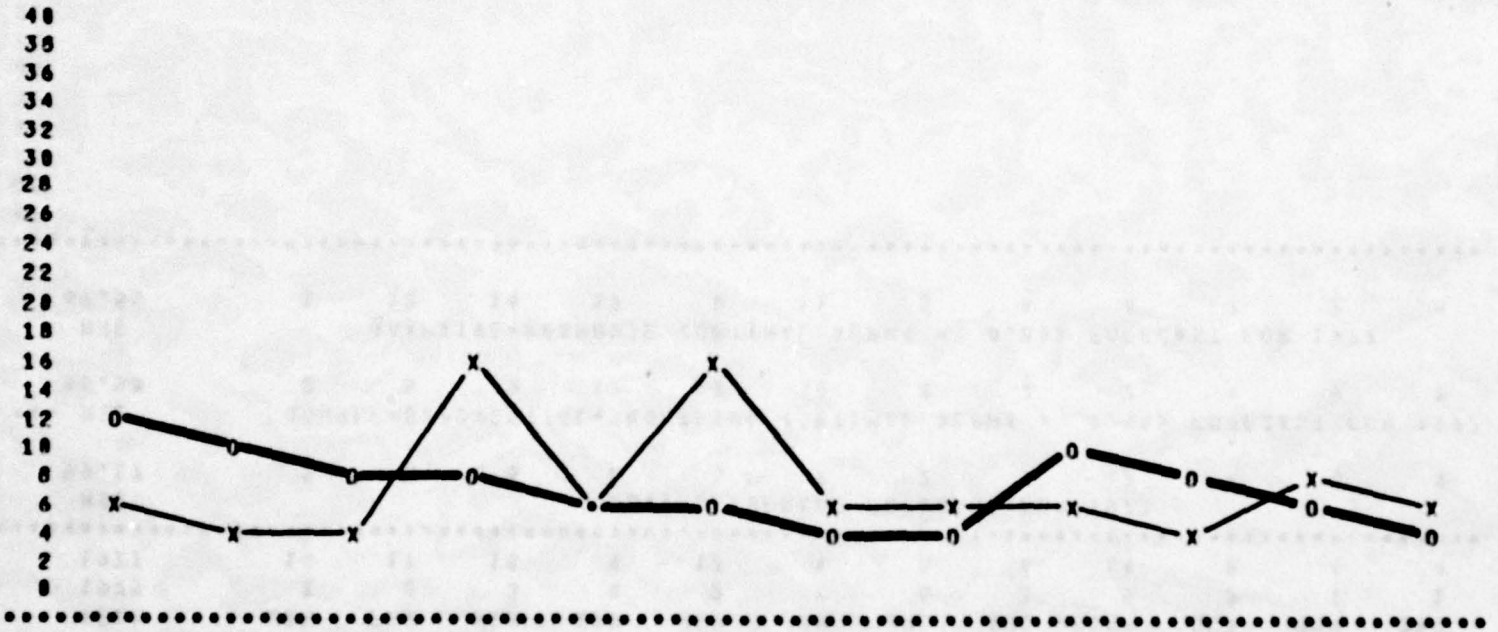
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505803758955

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	18	12	14	43	18	43	18	18	18	12	24	18
1977	20	17	13	14	18	11	7	8	18	15	12	9

MSE					MOVING-AVERAGE FORECAST FOR 1977							
41.42	21	22	22	22	19	19	16	15	14	14	15	14

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
17.16	19	20	17	13	14	18	11	7	8	17	15	12

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
13.50	17	19	19	18	15	14	10	10	9	8	16	15



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

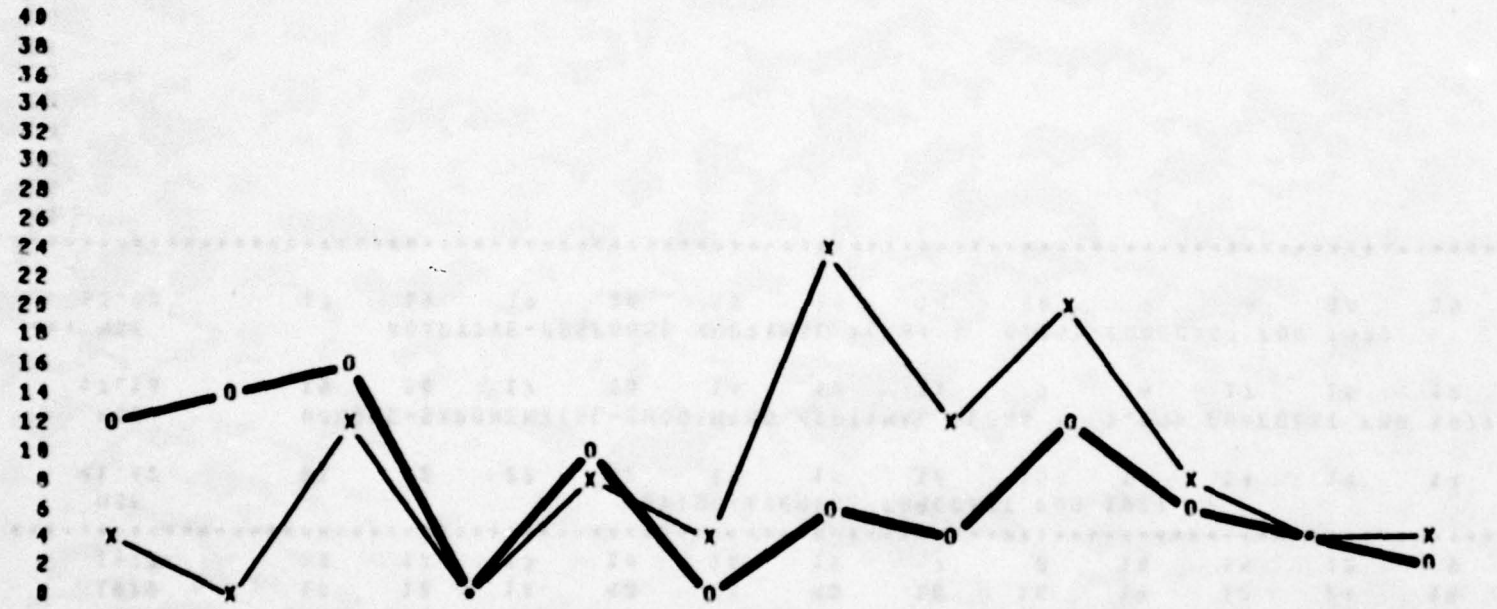
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505004341879

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	0	3	0	2	1	6	3	5	2	1	1
1977	14	17	18	0	13	1	8	6	14	8	6	4

MSE	MOVING-AVERAGE FORECAST FOR 1977											
59.17	2	3	5	6	6	7	7	7	7	8	8	9

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.50) FORECAST FOR 1977											
56.58	2	5	9	12	10	10	8	7	7	9	9	8

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.80) FORECAST FOR 1977											
69.58	1	12	16	17	8	11	5	6	6	7	7	6



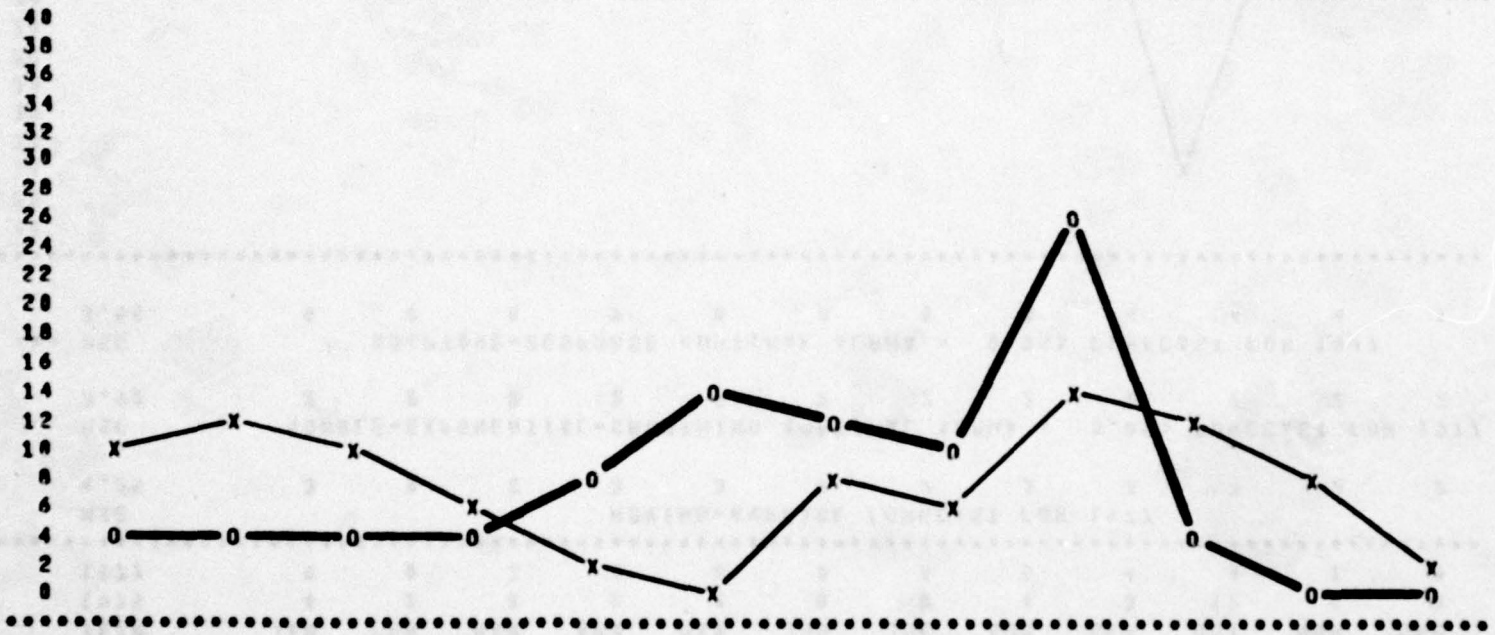
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005434048

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	34	43	37	22	9	3	31	25	49	46	27	9
1977	14	12	14	16	24	48	33	38	72	14	4	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
351.67	28	26	24	22	21	23	26	26	26	28	25	24

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
489.63	28	16	13	14	15	28	32	33	31	54	33	15

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977											
258.75	24	16	12	13	14	17	37	33	31	32	15	14



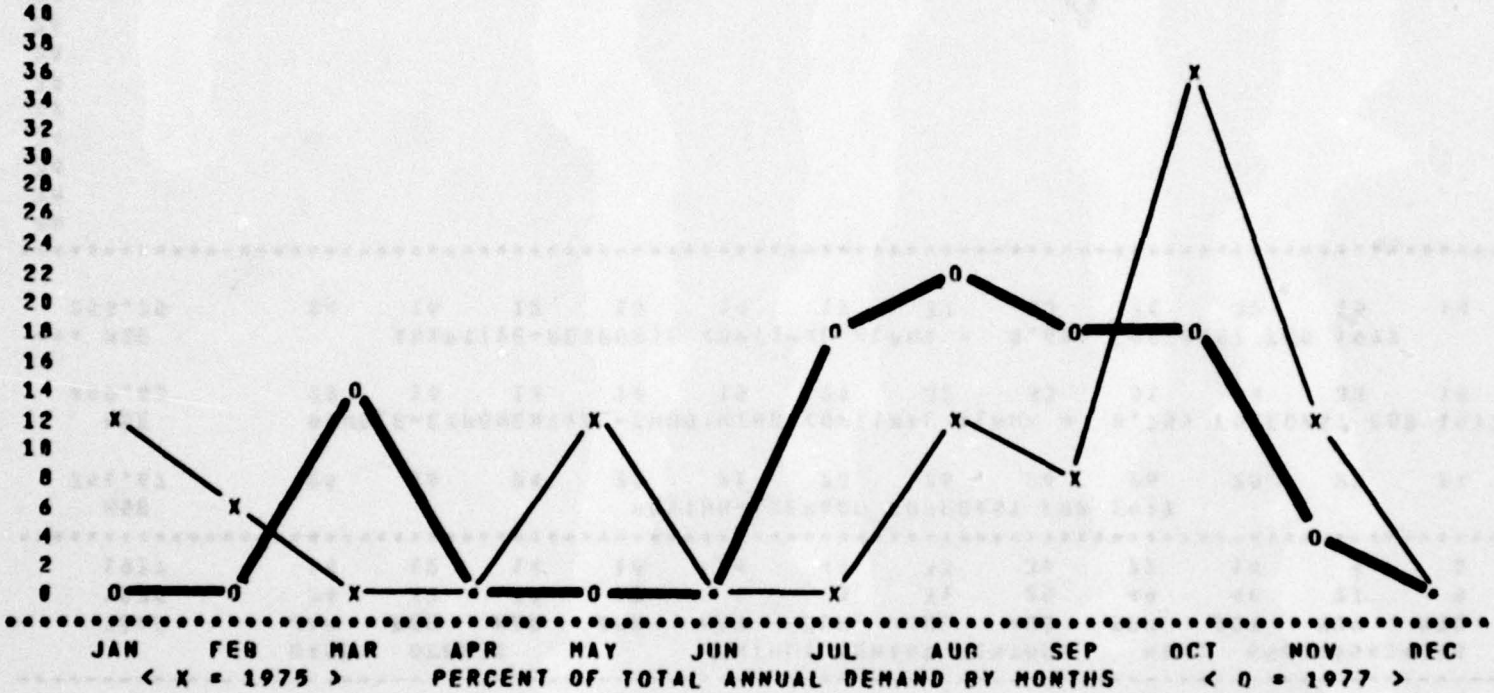
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005760915

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	2	0	0	4	0	0	4	3	12	4	0
1977	0	0	3	0	0	0	4	5	4	4	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
4.25	3	2	2	3	3	2	2	3	3	3	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
3.92	2	2	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
3.58	0	0	0	2	0	0	0	3	4	4	4	1



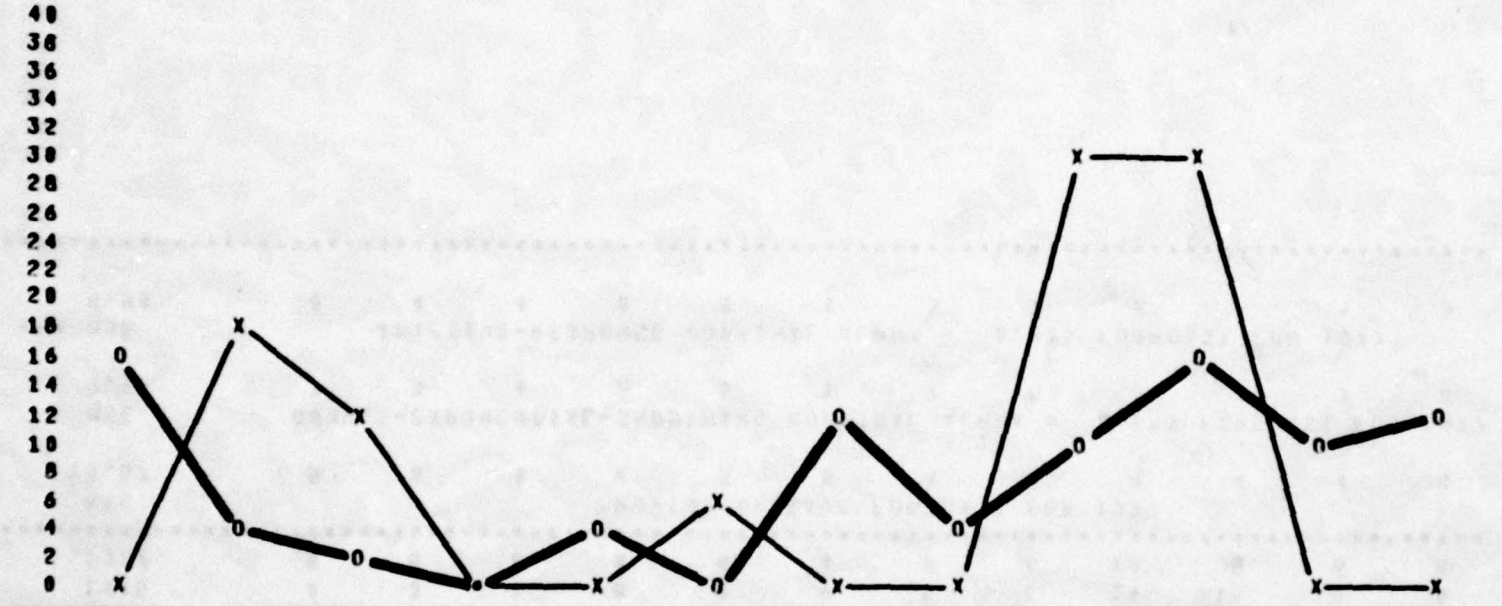
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005798432

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	3	2	0	0	1	0	0	5	5	0	0
1977	6	2	1	0	2	0	5	2	4	6	4	5

MSE	MOVING-AVERAGE FORECAST FOR 1977											
5.92	1	2	2	2	2	2	2	2	2	2	2	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
4.92	2	2	2	2	2	2	2	2	2	2	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
6.75	0	0	0	1	1	0	0	0	3	2	2	4



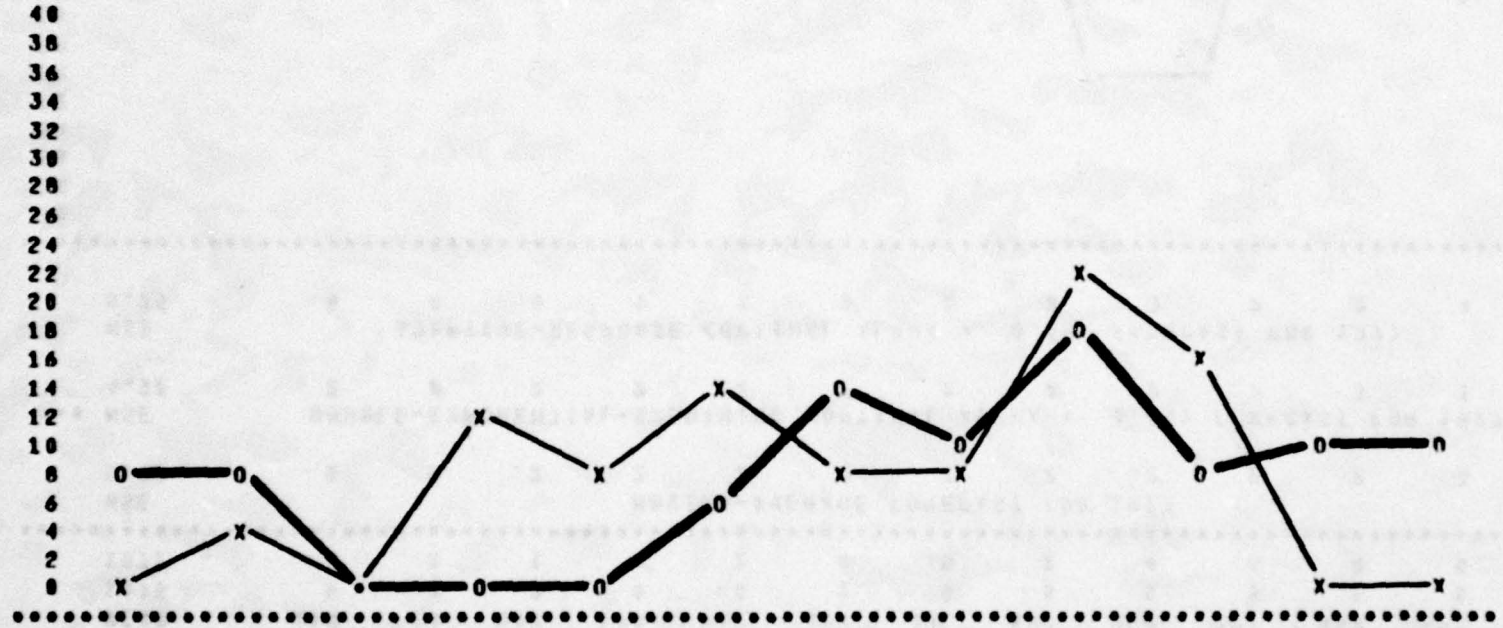
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005040412

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	3	1	8	6	9	5	6	14	10	0	0
1977	5	5	0	0	0	4	8	6	10	5	6	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
13.67	5	6	6	6	5	5	4	4	4	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
8.85	3	3	4	2	1	1	2	5	6	8	7	6

*** MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
8.58	0	4	4	6	8	8	3	7	6	6	5	5



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

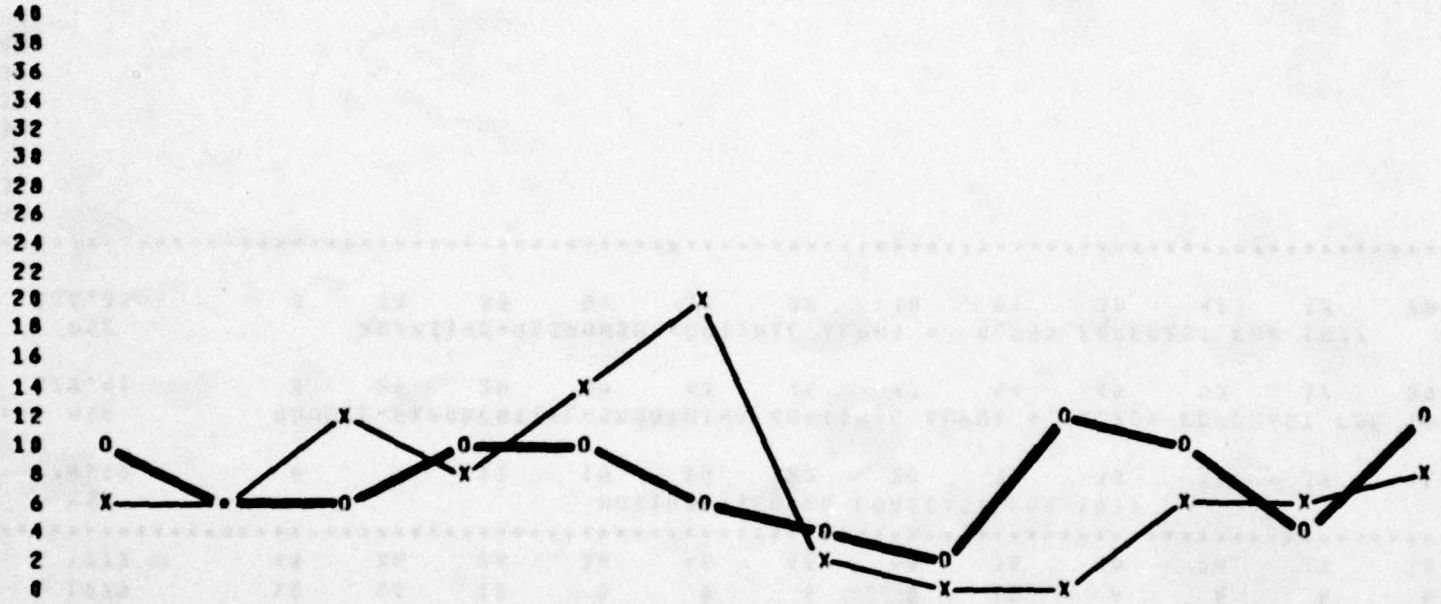
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005843179

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	4	7	5	8	11	2	8	1	4	4	5
1977	4	3	3	4	4	3	2	1	5	4	2	5

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.25	5	5	5	4	4	4	3	3	3	4	4	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
1.75	4	4	4	4	4	4	4	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
2.67	3	4	4	3	2	3	3	3	2	1	4	4



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

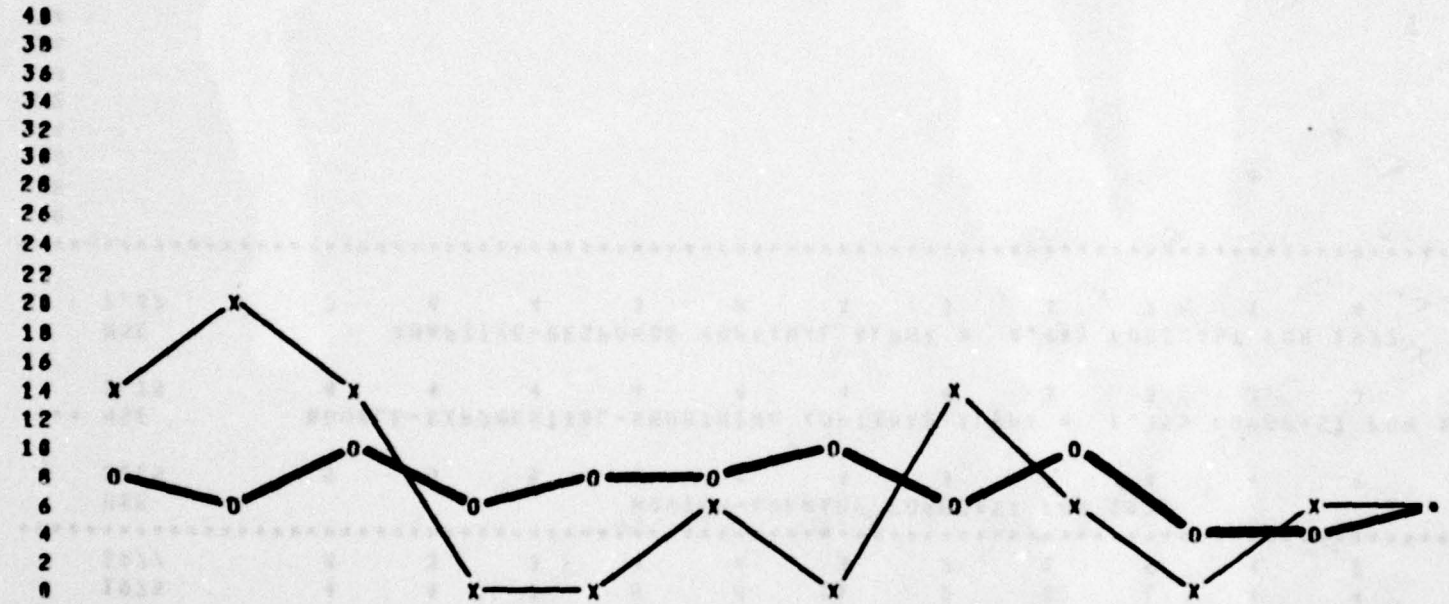
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006640856

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	16	12	0	0	6	0	12	6	0	6	6
1977	48	36	60	36	48	48	60	36	60	24	24	36

MSE					MOVING-AVERAGE FORECAST FOR 1977							
770.00	6	9	11	15	18	22	26	31	33	37	39	41

MSE					DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977							
375.41	5	29	35	49	43	45	47	54	45	53	37	29

MSE					ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977							
386.33	6	33	35	59	36	38	40	51	38	40	38	28



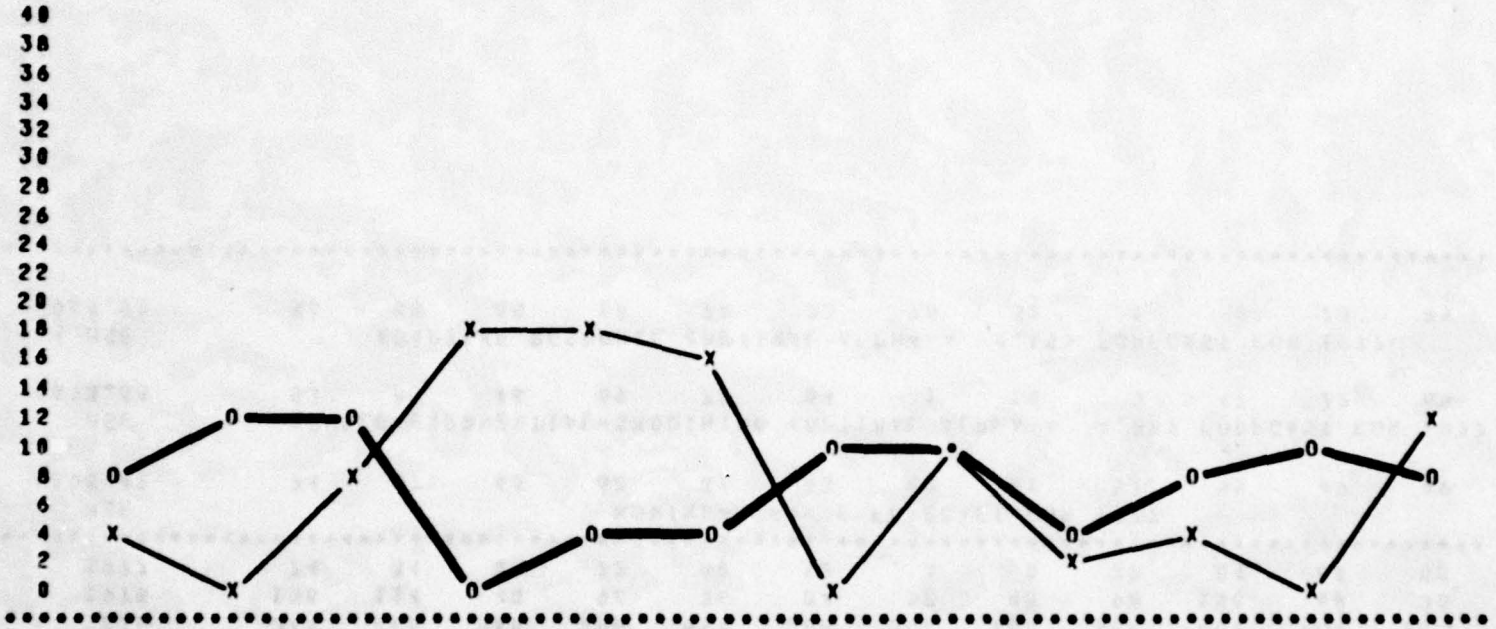
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006807352

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	0	4	8	8	7	0	5	1	2	0	6
1977	3	5	5	0	2	2	4	4	2	3	4	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.33	4	4	4	4	4	3	3	3	3	3	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
1.92	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977											
3.75	3	3	4	4	8	1	1	2	3	2	2	3



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

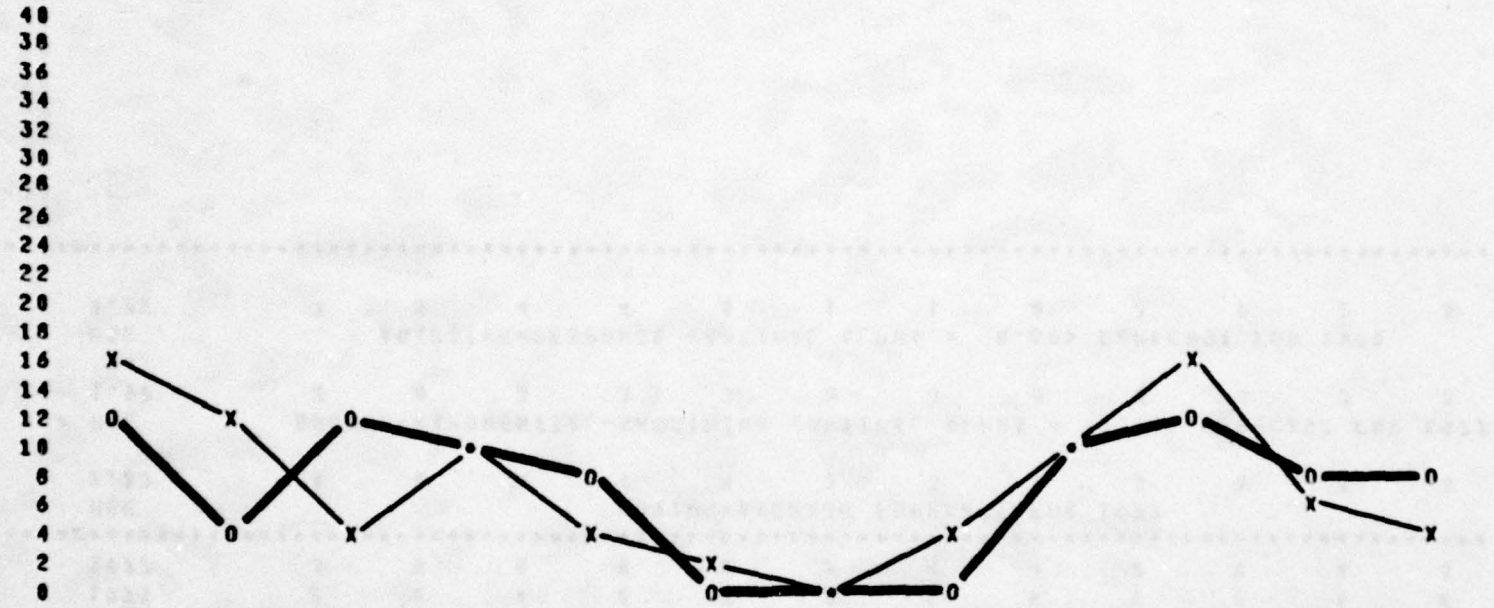
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006874482

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	156	114	48	96	36	24	12	48	96	156	60	36
1977	74	34	84	72	60	12	0	0	72	84	60	58

MSE					MOVING-AVERAGE FORECAST FOR 1977							
1898.42	74	67	60	63	61	63	62	61	57	55	49	49

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
1893.66	53	65	46	69	72	64	31	10	3	47	72	65

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
908.92	58	53	65	60	74	73	70	32	1	0	70	81



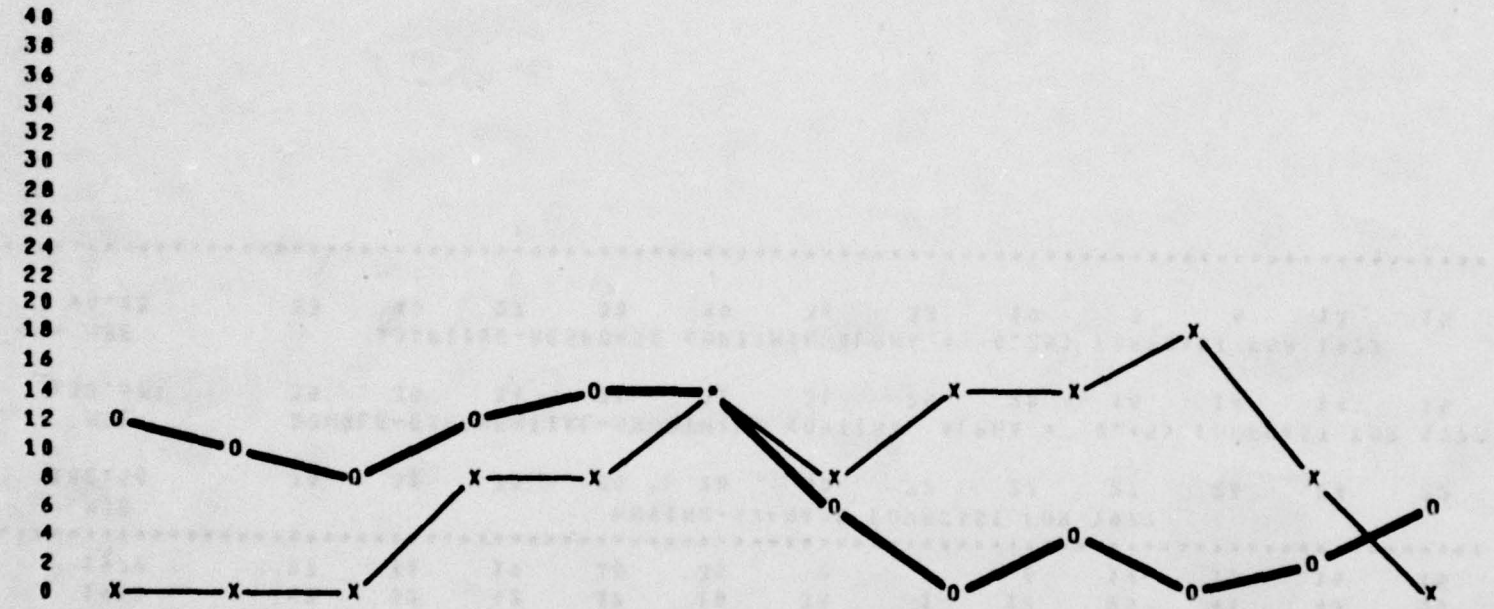
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006874534

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	24	24	36	24	36	36	48	24	0
1977	86	72	60	84	96	96	48	0	37	0	24	48

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1738.75	21	28	34	39	44	50	55	57	54	54	50	50

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
1268.42	14	53	66	64	75	87	93	68	28	31	14	18

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
1816.83	24	1	85	72	65	83	95	95	48	0	36	4



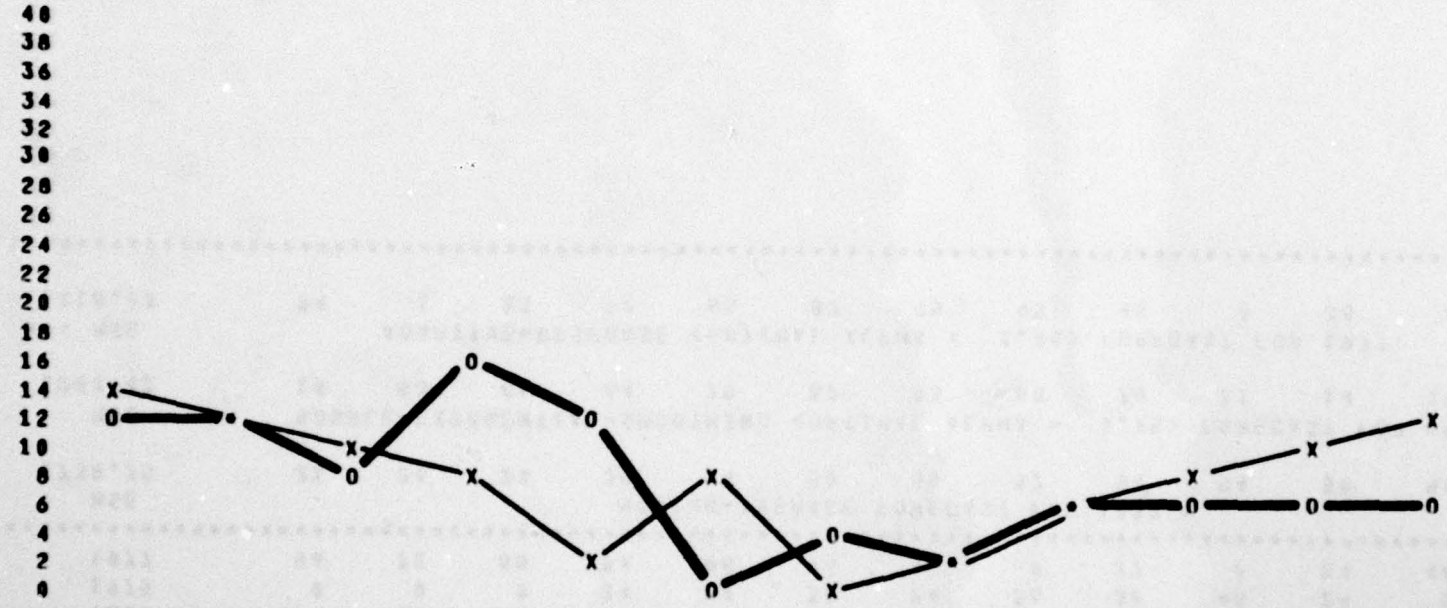
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006870285

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	62	52	42	37	10	38	1	10	25	41	43	50
1977	27	31	19	38	31	2	9	6	14	17	16	15

MSE	MOVING-AVERAGE FORECAST FOR 1977											
102.50	34	31	30	28	28	30	27	27	27	26	24	22

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
130.67	35	35	34	31	31	31	25	20	16	14	14	15

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
96.88	33	49	27	38	29	36	33	19	9	6	13	15



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

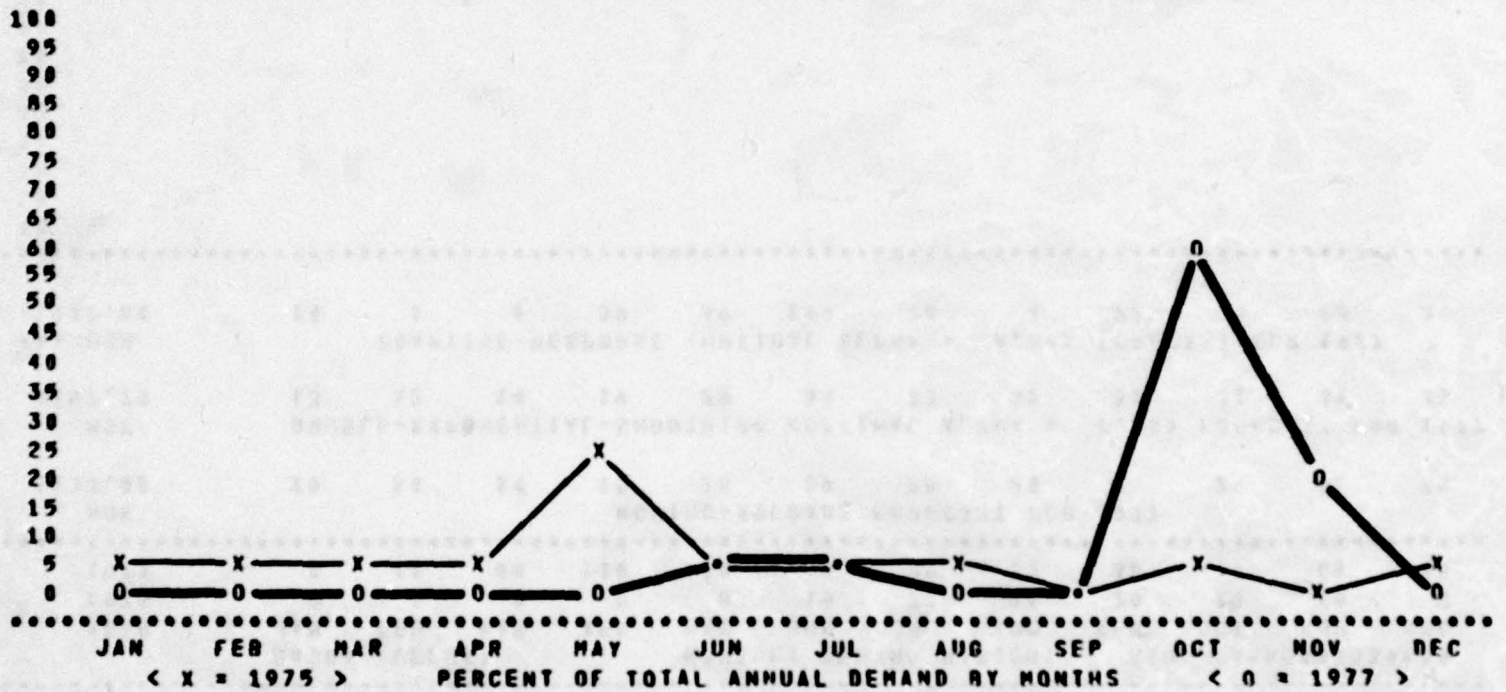
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007534773

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	2	3	3	9	3	2	3	0	2	0	2
1977	0	0	0	0	0	1	1	0	0	0	3	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
6.75	3	2	2	2	2	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.25) FORECAST FOR 1977											
6.88	2	2	2	2	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.10) FORECAST FOR 1977											
5.92	0	0	0	0	0	0	0	0	0	0	0	7



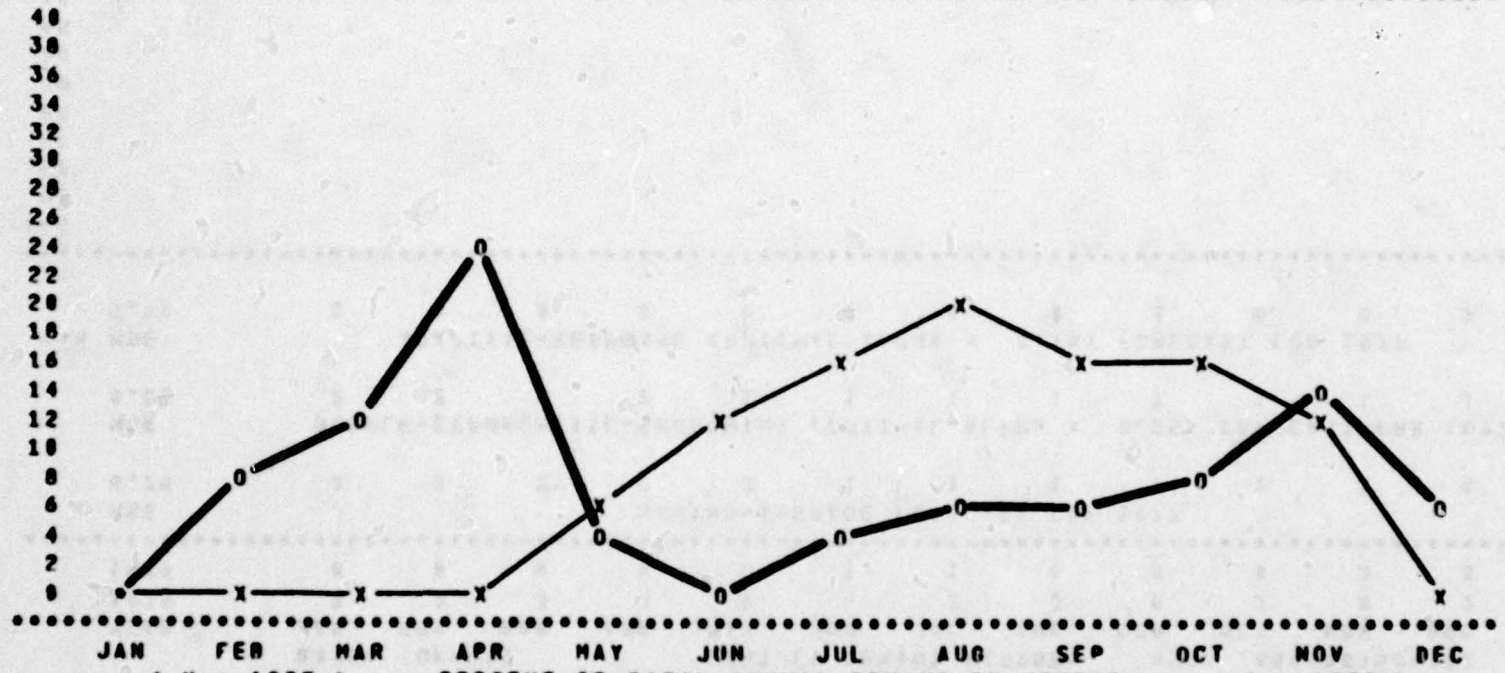
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007539609

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	2	0	15	20	25	20	20	15	0
1977	0	40	60	110	20	0	25	30	30	40	65	35

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1133.00	10	10	14	19	28	29	28	28	28	29	31	35

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
1157.75	13	12	14	19	29	34	33	32	31	31	31	35

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
1079.00	14	0	0	39	59	109	20	4	22	25	28	39



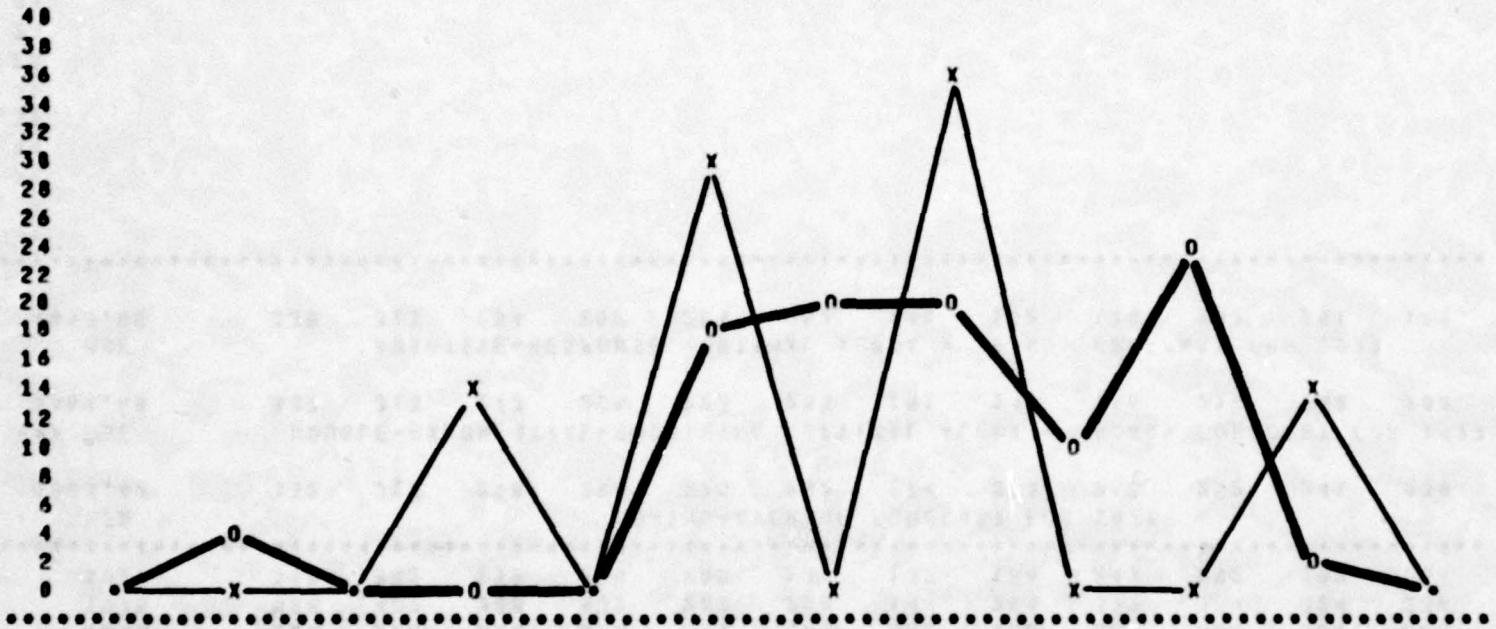
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007540876

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	10	0	20	0	24	1	9	10	0
1977	0	4	0	0	0	10	20	20	10	24	3	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
93.17	5	5	6	6	5	5	5	6	4	7	9	8

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
84.25	3	1	3	1	0	0	10	16	19	14	19	10

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
74.88	0	0	0	3	0	0	0	15	19	19	10	23



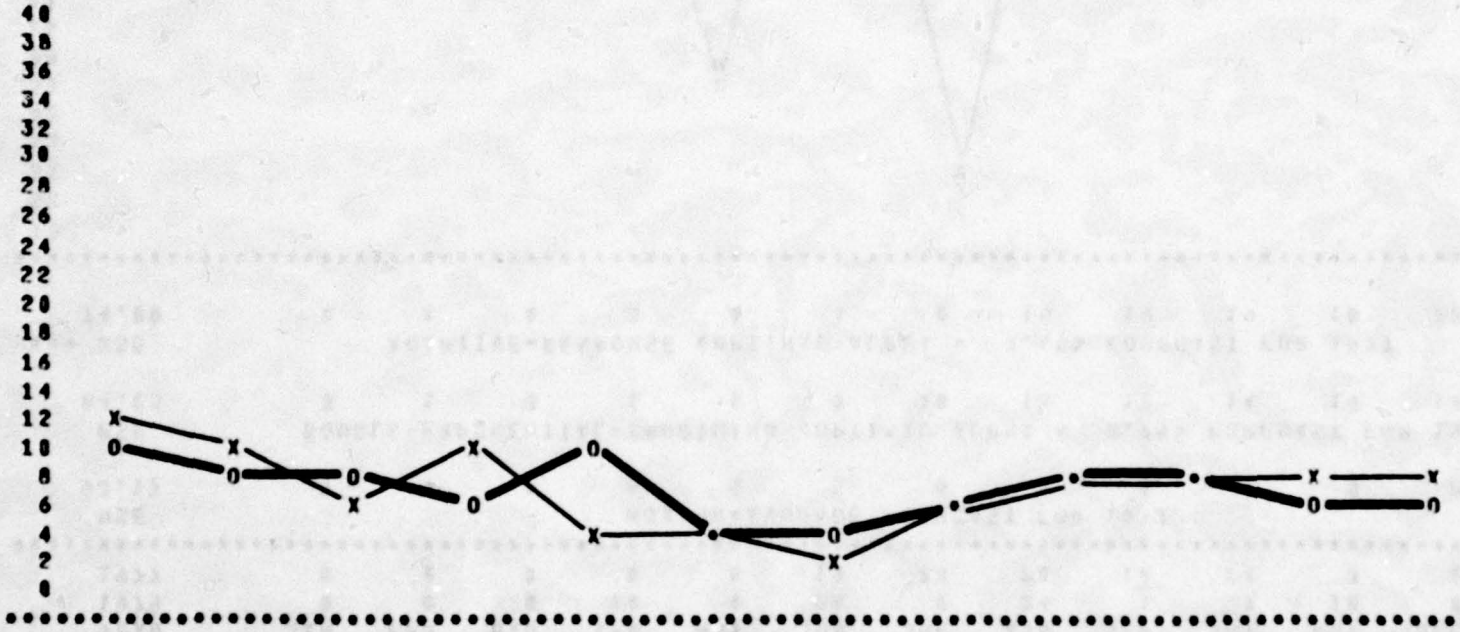
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007540381

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	528	432	288	432	222	228	144	294	372	384	324	336
1977	388	252	252	284	288	132	132	188	248	252	188	284

MSE	MOVING-AVERAGE FORECAST FOR 1977											
5884.42	332	313	298	295	276	282	274	273	263	252	241	230

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.88> FORECAST FOR 1977											
3686.65	337	313	273	258	223	263	181	146	166	214	240	208

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
4883.88	335	313	254	252	284	287	140	132	178	237	251	188



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

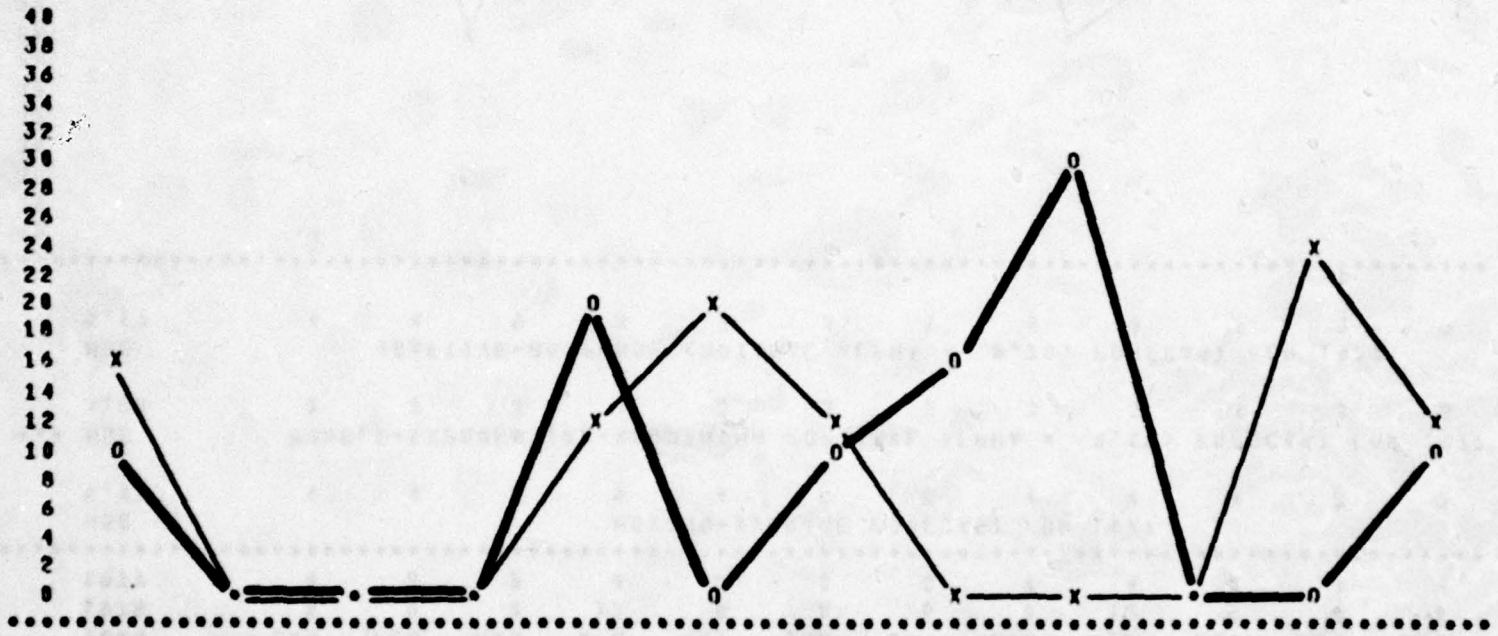
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007643348

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	48	0	0	0	36	60	36	0	0	0	72	36
1977	12	0	0	0	24	0	12	20	36	0	0	12

MSE	MOVING-AVERAGE FORECAST FOR 1977											
251.92	24	21	21	21	21	20	15	13	15	18	18	12

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.85) FOPECAST FOR 1977											
184.92	16	17	17	17	17	17	17	17	17	17	17	17

••• MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.85) FORECAST FOR 1977											
174.88	23	47	44	19	3	0	21	13	12	15	20	3



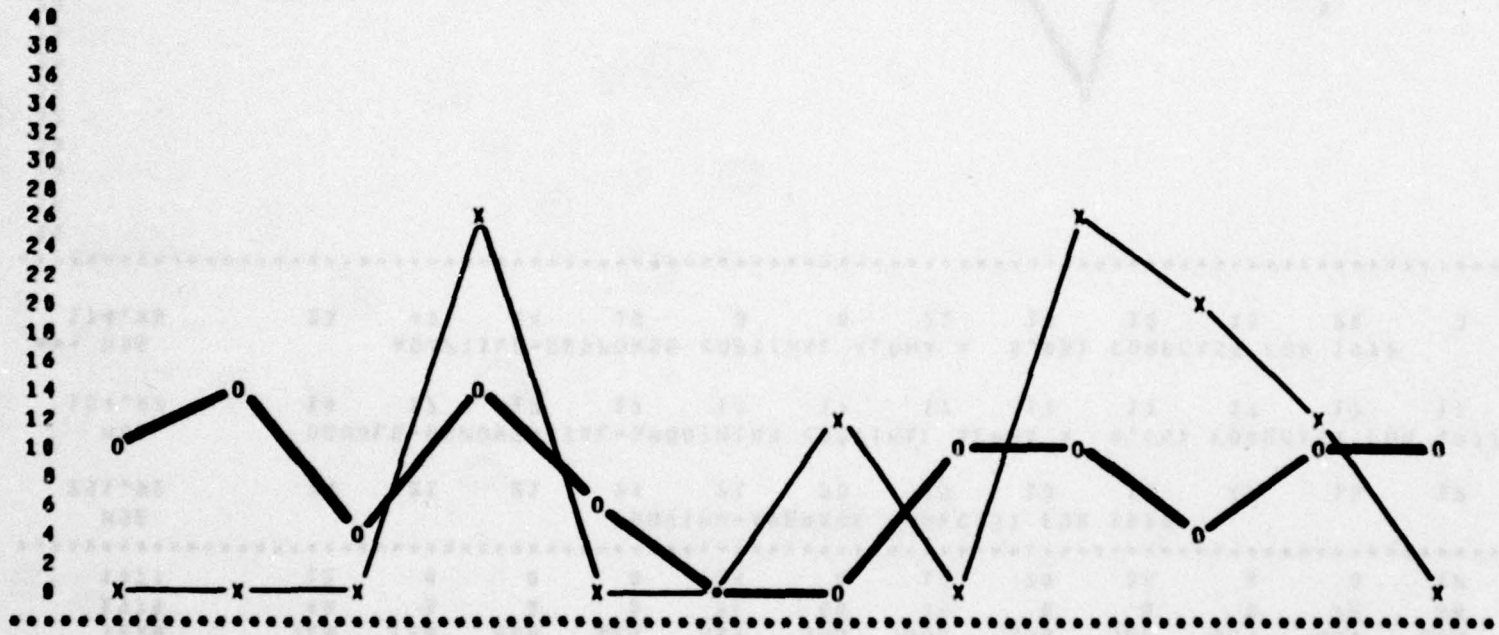
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007826484

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	12	0	0	6	0	12	9	6	0
1977	4	6	2	6	3	0	0	4	4	2	4	4

MSE	MOVING-AVERAGE FORECAST FOR 1977											
5.92	4	4	5	5	4	5	5	4	4	4	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
3.83	2	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
5.17	4	4	5	3	5	3	1	0	3	3	2	2



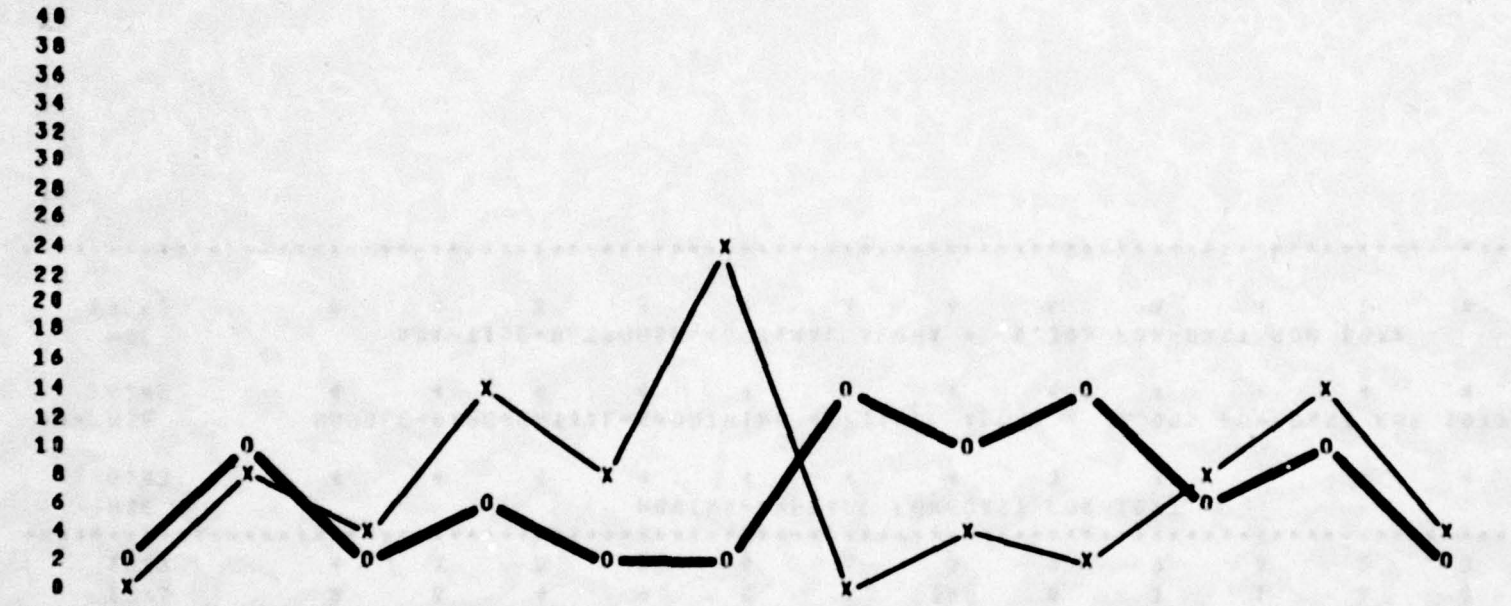
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007026518

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	4	2	6	4	10	0	2	1	4	6	2
1977	1	3	1	2	1	1	4	3	4	2	3	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.42	3	4	3	3	3	3	2	2	2	3	3	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
1.33	2	2	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.30) FORECAST FOR 1977											
1.58	2	2	1	2	1	1	1	1	3	3	3	2



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

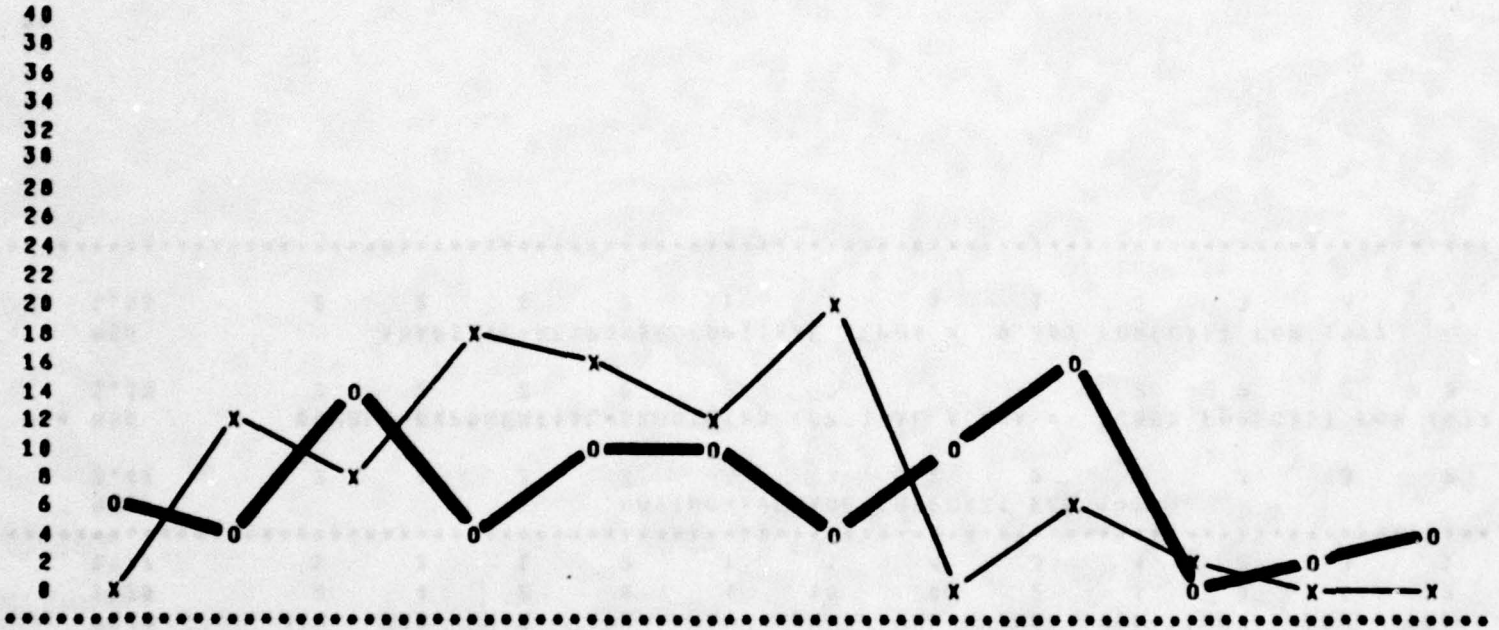
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008094241

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	4	9	8	6	10	0	3	1	0	0
1977	4	3	8	3	6	6	3	6	9	0	2	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
6.83	4	4	4	4	4	4	4	3	4	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
6.42	4	4	4	4	4	4	4	4	4	4	4	4

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.30) FORECAST FOR 1977											
13.50	0	0	3	3	7	3	4	5	3	4	7	0



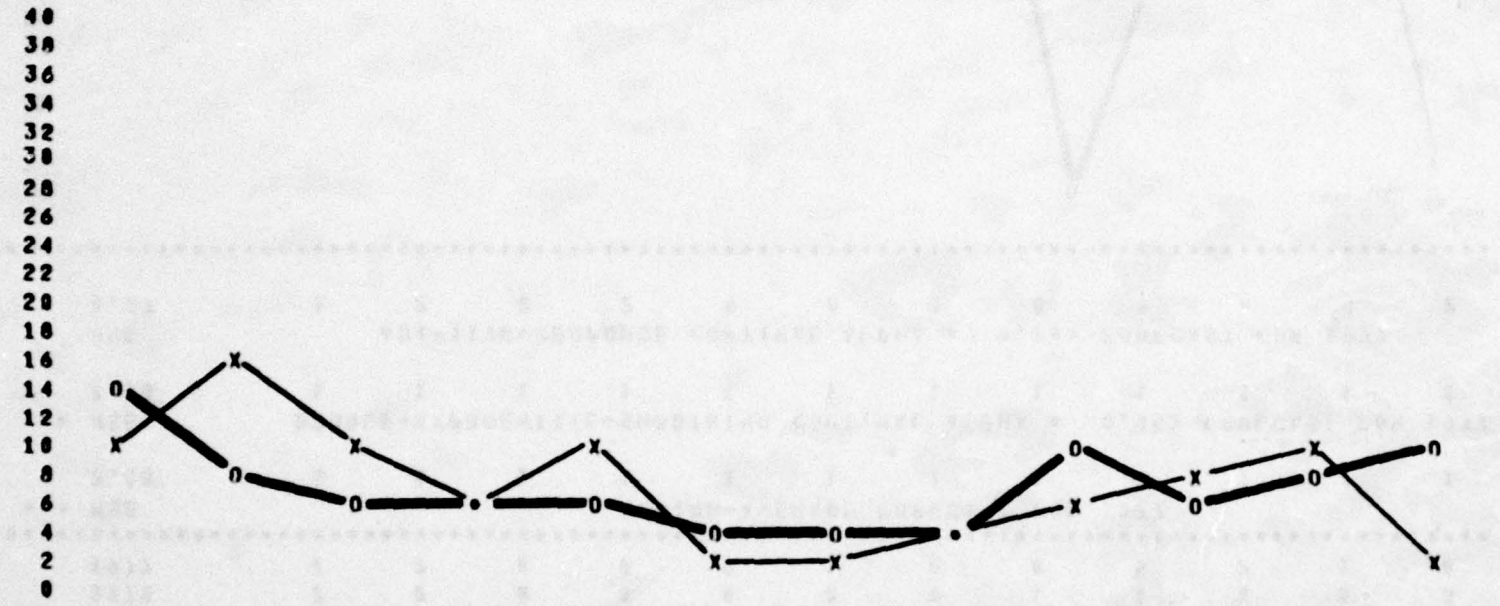
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008694177

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	224	324	216	155	204	71	72	116	138	168	228	72
1977	108	72	54	56	48	38	42	36	81	48	58	80

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3172.88	166	156	135	122	113	100	98	95	88	84	74	59

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977											
438.13	108	105	78	58	56	50	40	42	37	73	53	57

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
531.92	86	91	98	88	65	51	39	41	37	70	53	53



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

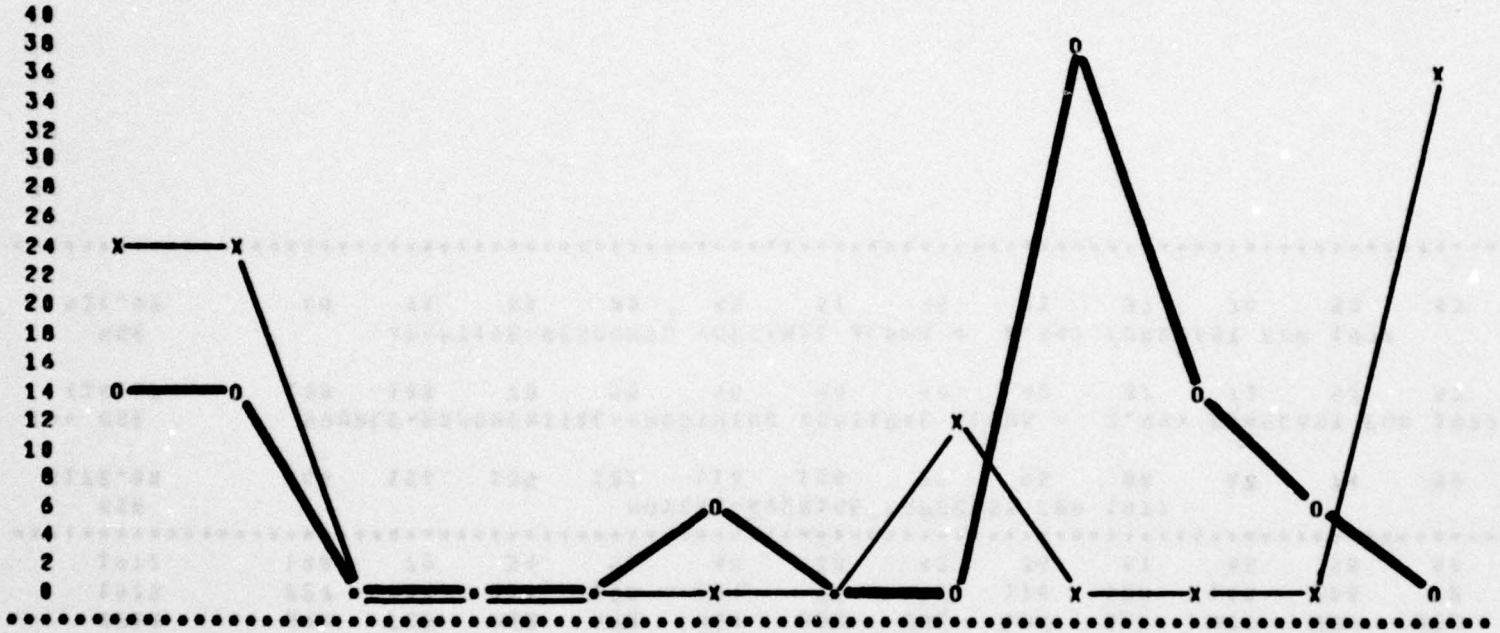
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008718307

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	2	0	0	0	0	0	1	0	0	0	3
1977	2	2	0	0	0	1	0	0	5	2	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.08	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
2.08	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
2.67	1	2	2	2	0	0	0	0	0	0	4	2



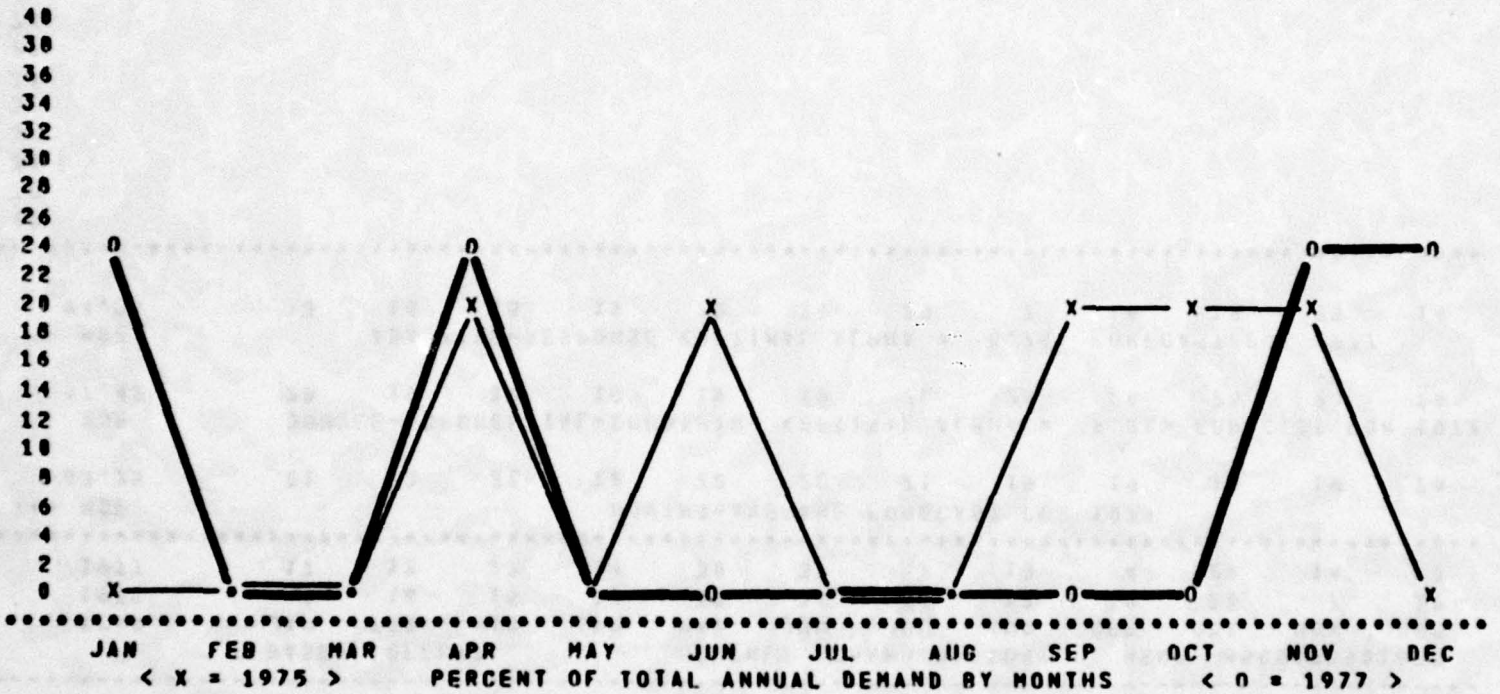
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008767239

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	1	0	1	0	0	1	1	1	0
1977	1	0	0	1	0	0	0	0	0	0	1	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.58	0	1	1	1	1	1	0	0	0	0	0	0

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
0.33	0	0	0	0	0	0	0	0	0	0	0	0

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
0.25	0	0	0	0	0	0	0	0	0	0	0	1



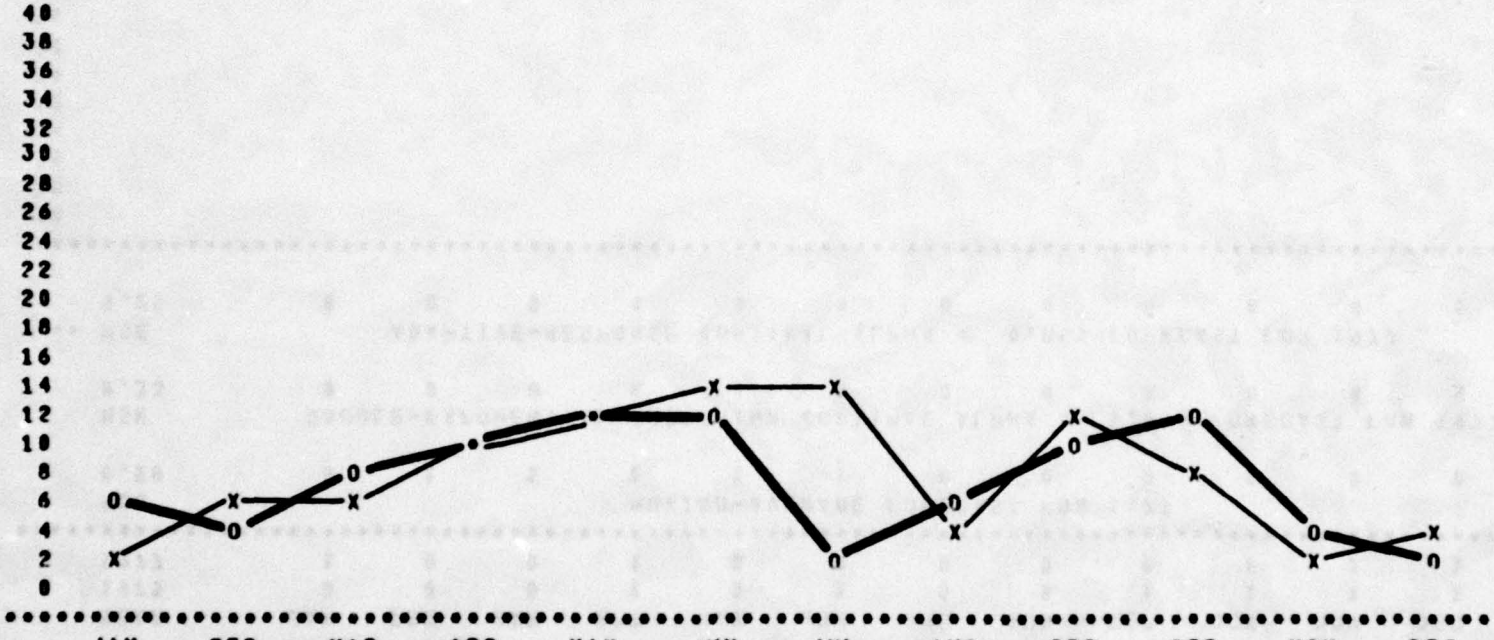
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008901633

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	16	15	27	30	36	36	12	30	20	7	12
1977	17	12	22	24	30	30	7	18	24	29	14	7

MSE	MOVING-AVERAGE FORECAST FOR 1977											
63.75	21	22	21	22	22	22	21	19	19	19	19	20

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
67.42	20	19	19	19	19	19	20	20	20	20	20	20

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
94.25	13	16	15	19	22	29	29	7	16	18	25	14



BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505008981726

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	3	0	0	0	0	0	0	3	5	4	2
1977	2	3	0	0	0	0	3	4	3	5	0	0

MOVING-AVERAGE FORECAST FOR 1977

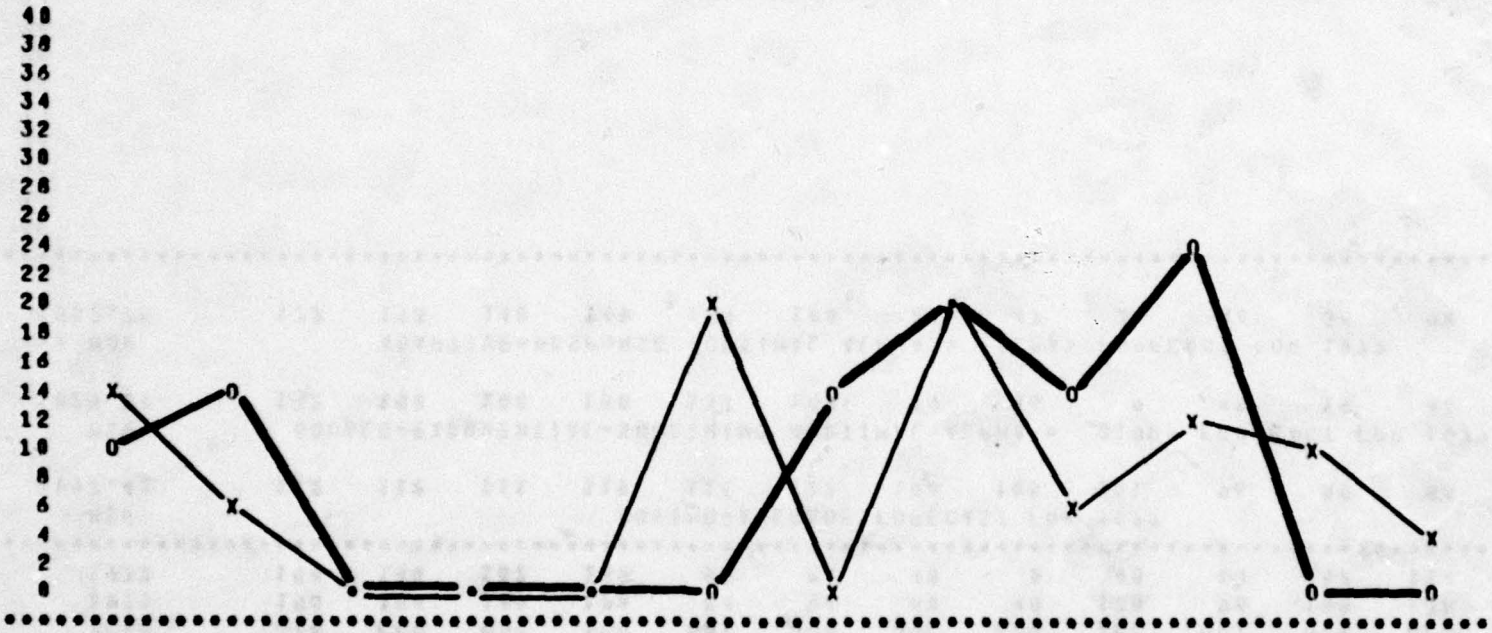
MSE												
4.75	3	3	3	3	3	3	2	3	2	2	2	2

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

MSE												
4.25	3	2	3	1	0	0	0	2	4	3	4	1

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

MSE												
3.17	2	2	2	0	0	0	0	2	3	3	4	0



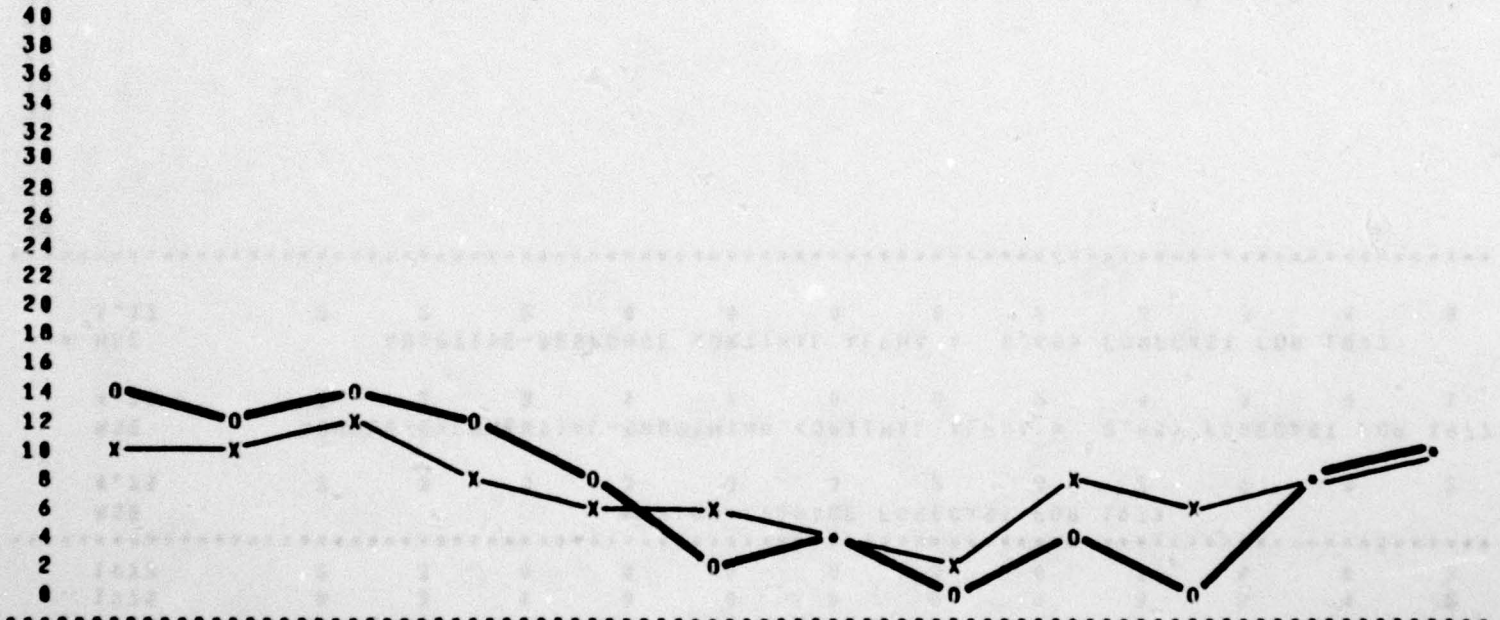
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505008902827

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	156	156	168	126	84	96	60	48	108	96	108	138
1977	154	148	162	132	96	24	48	0	48	14	102	114

MSE					MOVING-AVERAGE FORECAST FOR 1977							
3197.42	112	112	111	110	111	112	106	105	101	96	89	88

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.98> FORECAST FOR 1977											
1825.39	132	150	142	150	137	104	39	46	9	48	19	86

*** MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
1567.75	127	153	140	149	134	108	26	47	35	46	36	94



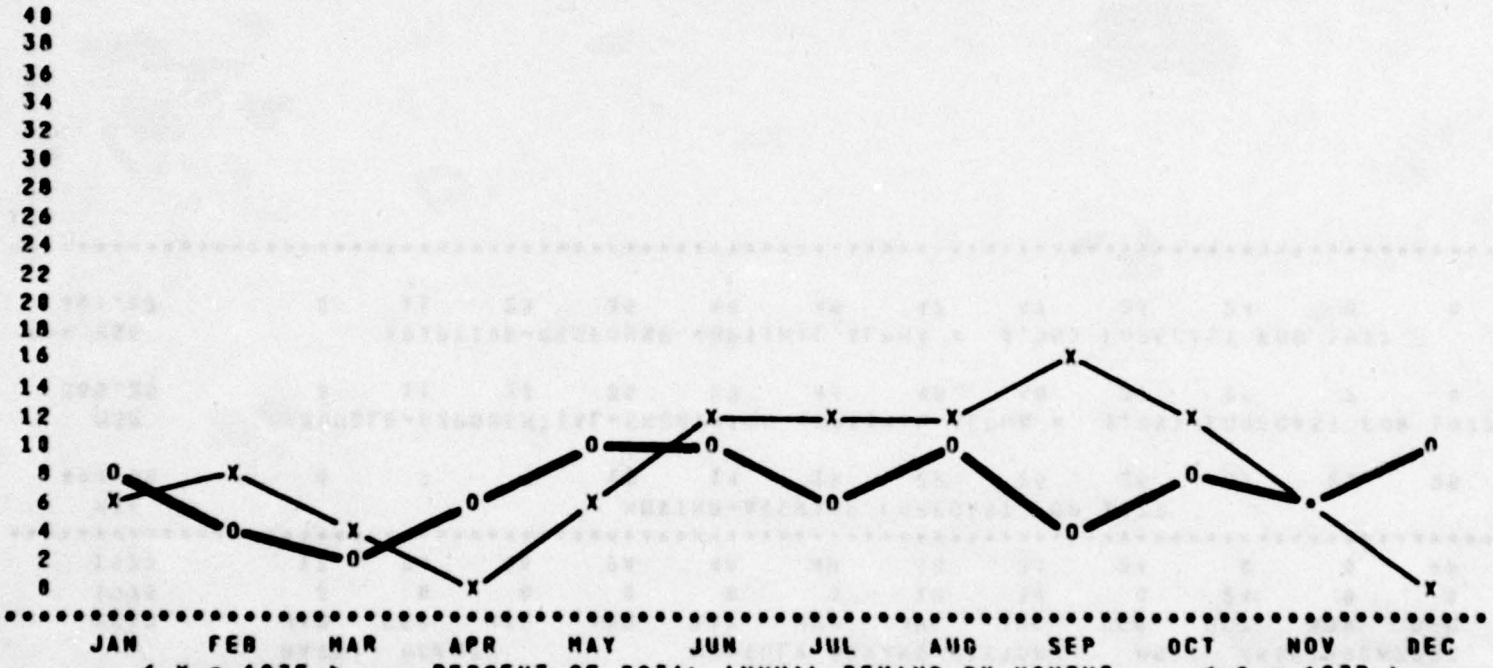
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008902172

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	10	12	6	8	10	10	20	10	24	10	10	8
1977	23	12	7	10	30	30	20	29	11	24	20	30

MSE					MOVING-AVERAGE FORECAST FOR 1977							
77.00	12	13	13	13	15	17	10	10	10	17	10	19

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
77.50	13	14	14	12	13	17	20	22	23	21	21	21

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
94.50	10	0	22	13	9	17	20	29	20	20	14	22



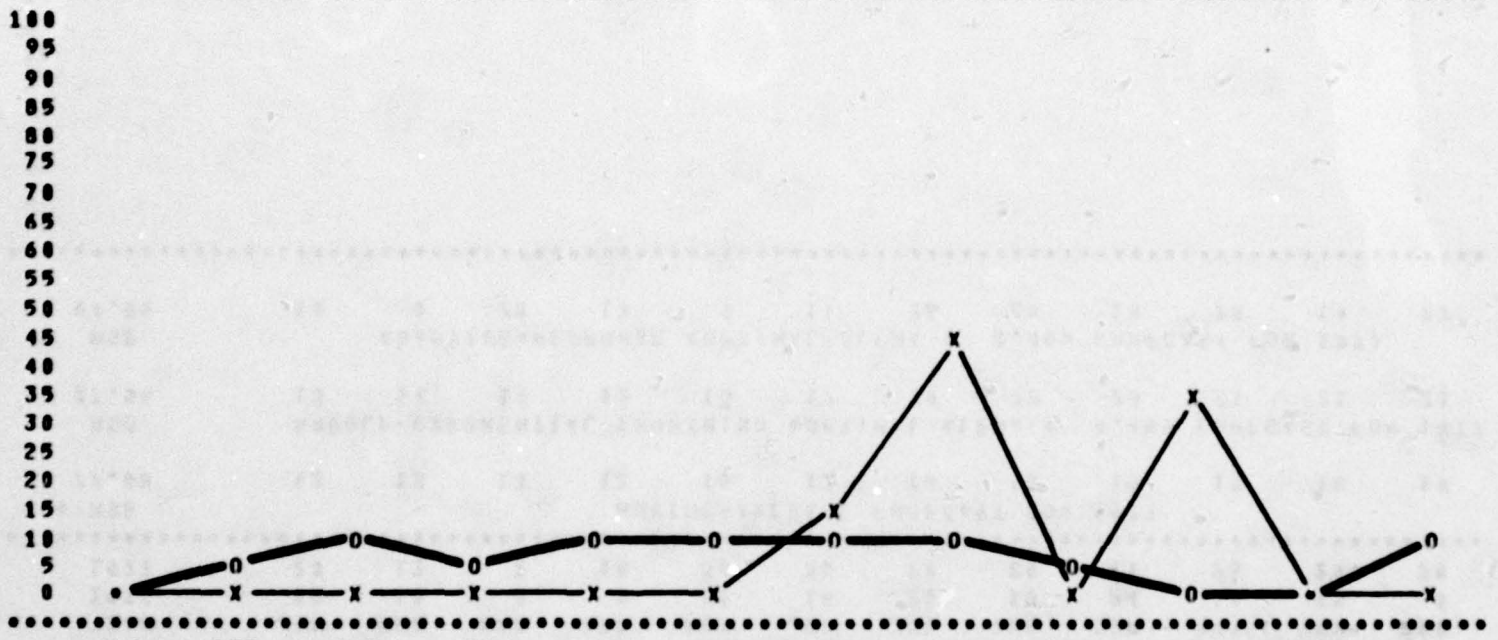
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505009262897

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	0	12	38	0	24	0	0
1977	12	24	36	24	48	48	48	36	24	0	0	48

MSE	MOVING-AVERAGE FORECAST FOR 1977											
494.58	6	7	9	12	14	18	22	25	25	27	25	25

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.95) FORECAST FOR 1977											
365.35	0	11	23	35	25	46	48	48	37	25	2	0

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.95) FORECAST FOR 1977											
361.17	0	11	23	35	24	45	47	47	36	24	0	0



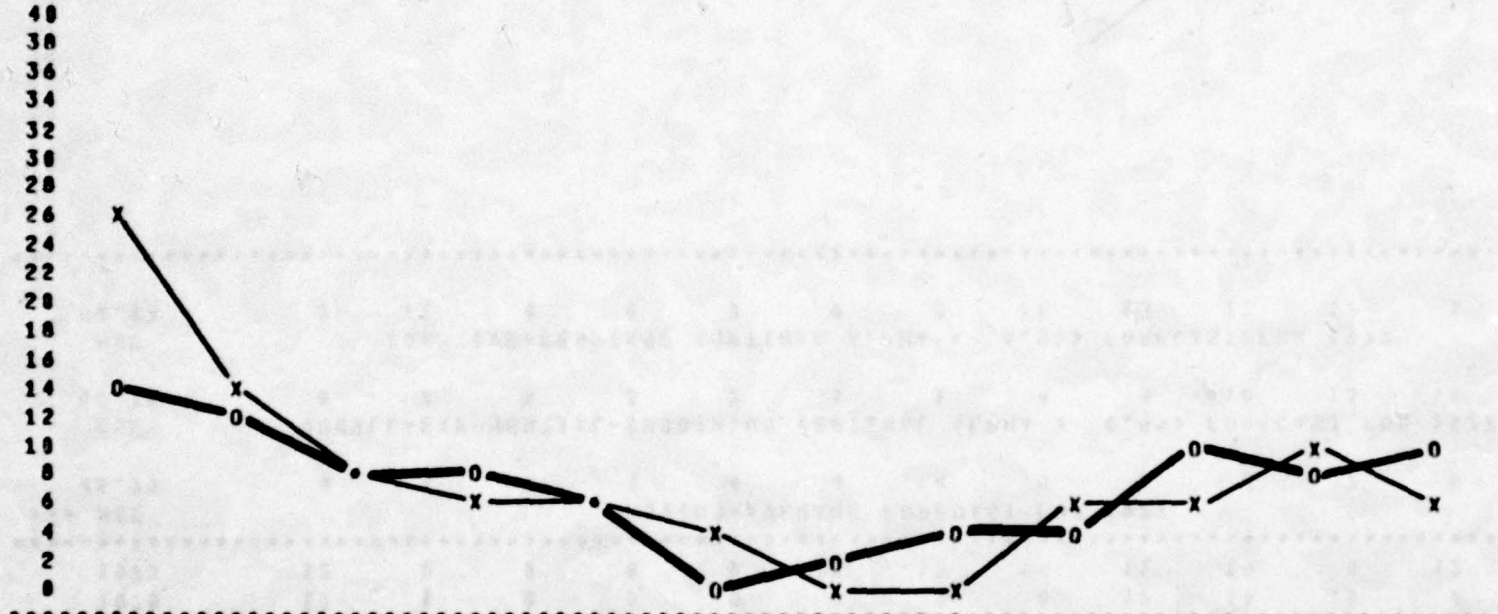
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505809268985

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1632	835	576	402	384	306	0	0	360	378	672	408
1977	414	364	228	222	174	51	96	105	156	288	250	276

MSE					MOVING-AVERAGE FORECAST FOR 1977							
16253.25	496	395	355	326	311	294	273	281	289	272	265	238

••• MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
5549.42	432	415	369	242	224	179	63	93	184	151	275	253

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977											
6888.33	488	412	388	233	222	174	51	95	180	146	287	258



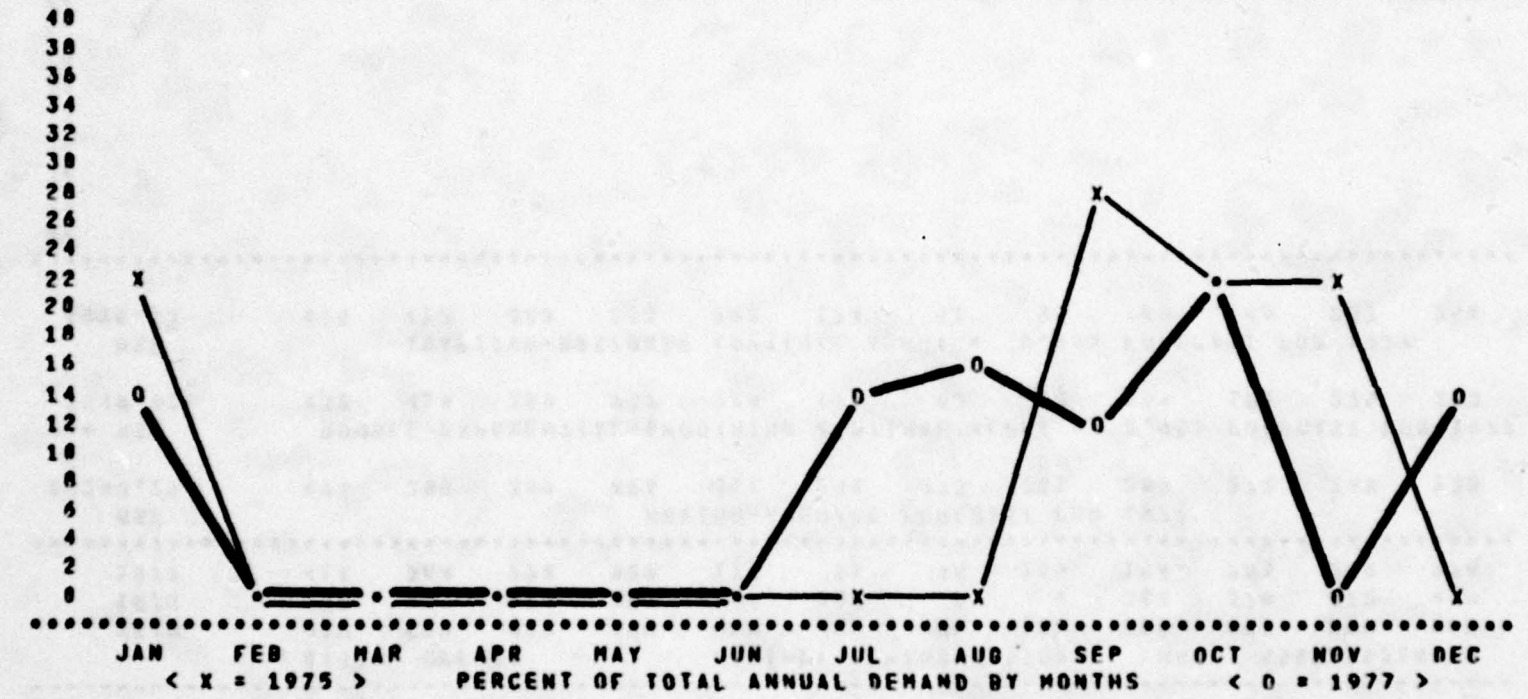
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505809249202

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	10	0	0	0	0	0	0	0	12	10	10	0
1977	12	0	0	0	0	1	12	14	11	19	0	12

MSE												
	MOVING-AVERAGE FORECAST FOR 1977											
46.75	4	4	4	4	4	4	4	5	6	6	7	6
	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977											
50.78	6	7	5	3	2	1	1	4	8	10	13	10
	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
56.67	5	11	4	0	0	0	0	10	13	11	12	1



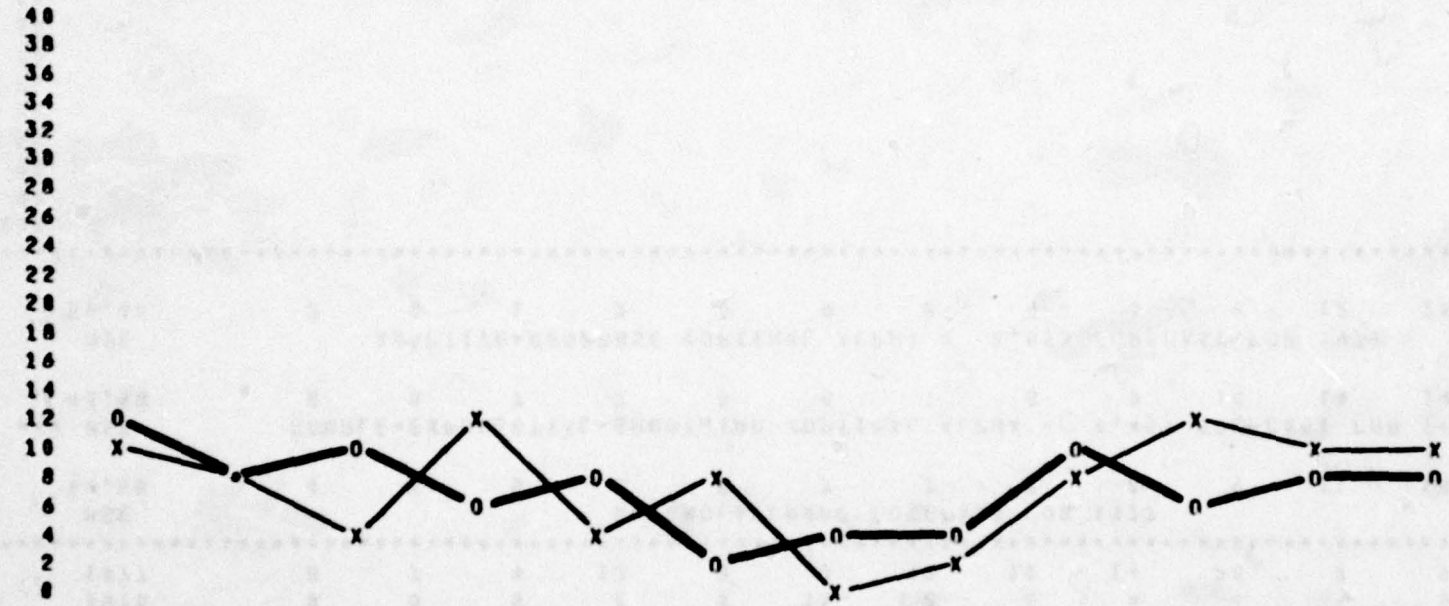
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009354095

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1056	960	484	1260	588	864	192	336	1008	1440	1056	1248
1977	796	579	675	439	538	243	384	339	755	488	624	566

MSE					MOVING-AVERAGE FORECAST FOR 1977							
74927.42	874	852	828	836	768	764	712	728	728	787	627	591

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FOPECAST FOR 1977											
51751.78	1211	913	665	667	582	519	328	362	346	641	531	596

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
48218.75	1148	939	651	674	546	530	251	383	366	504	481	552



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

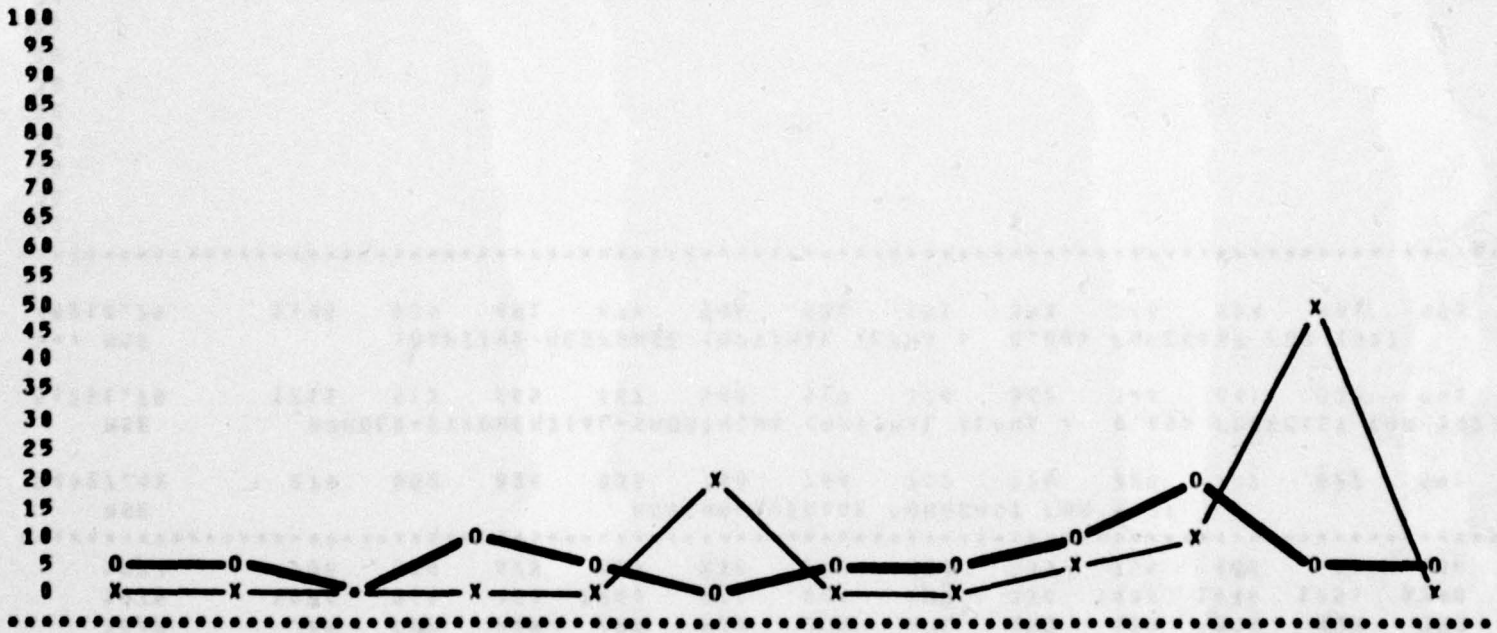
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009444130

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	11	2	0	4	6	24	0
1977	0	7	4	13	8	3	12	10	14	28	7	9

MSE	MOVING-AVERAGE FORECAST FOR 1977											
44.58	4	5	5	6	7	7	7	7	8	9	11	10

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
43.58	8	8	7	7	8	8	7	8	9	10	14	14

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
59.88	2	0	1	2	3	9	8	4	6	8	12	26



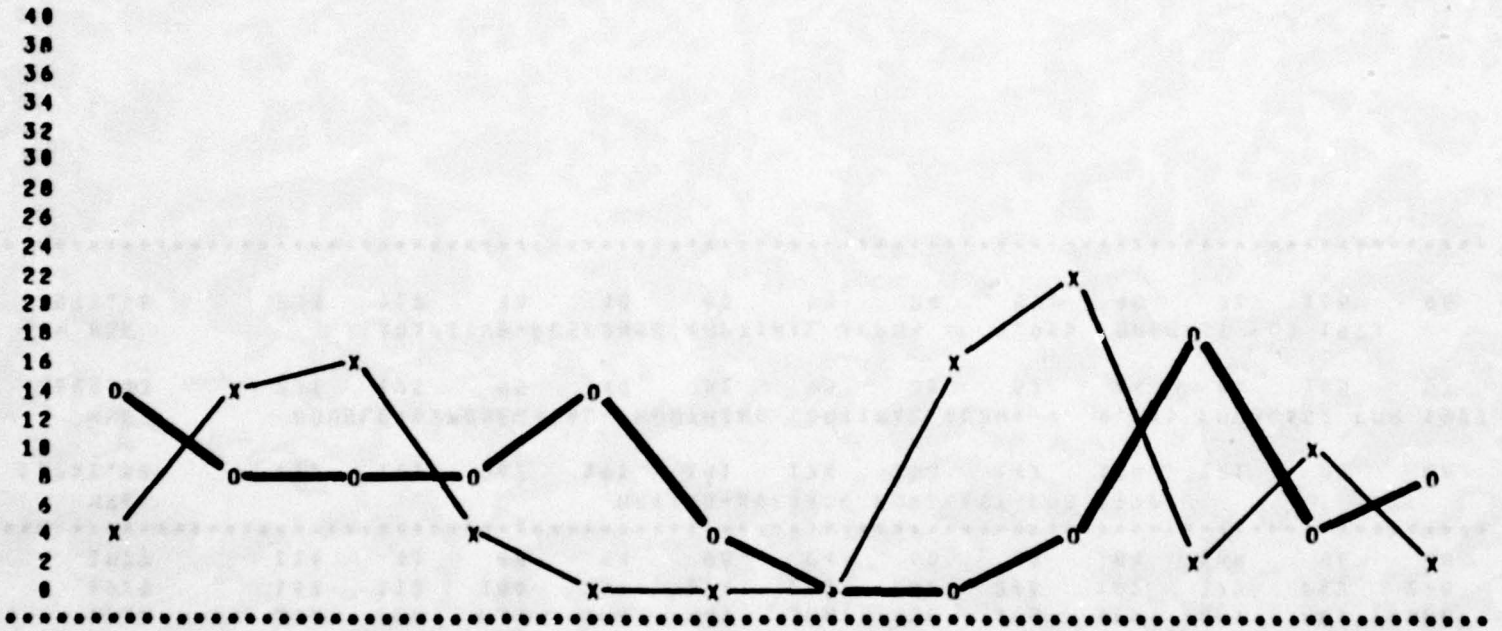
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: %5805009464700

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	100	250	300	100	0	0	0	300	400	50	200	50
1977	150	100	100	100	150	50	0	0	50	200	50	100

MSE					MOVING-AVERAGE FORECAST FOR 1977							
5856.83	146	150	138	121	121	133	138	138	113	83	96	83

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
4304.17	149	141	129	119	111	119	104	74	48	42	88	82

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977											
4334.58	128	135	132	116	104	142	94	38	3	46	74	53



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

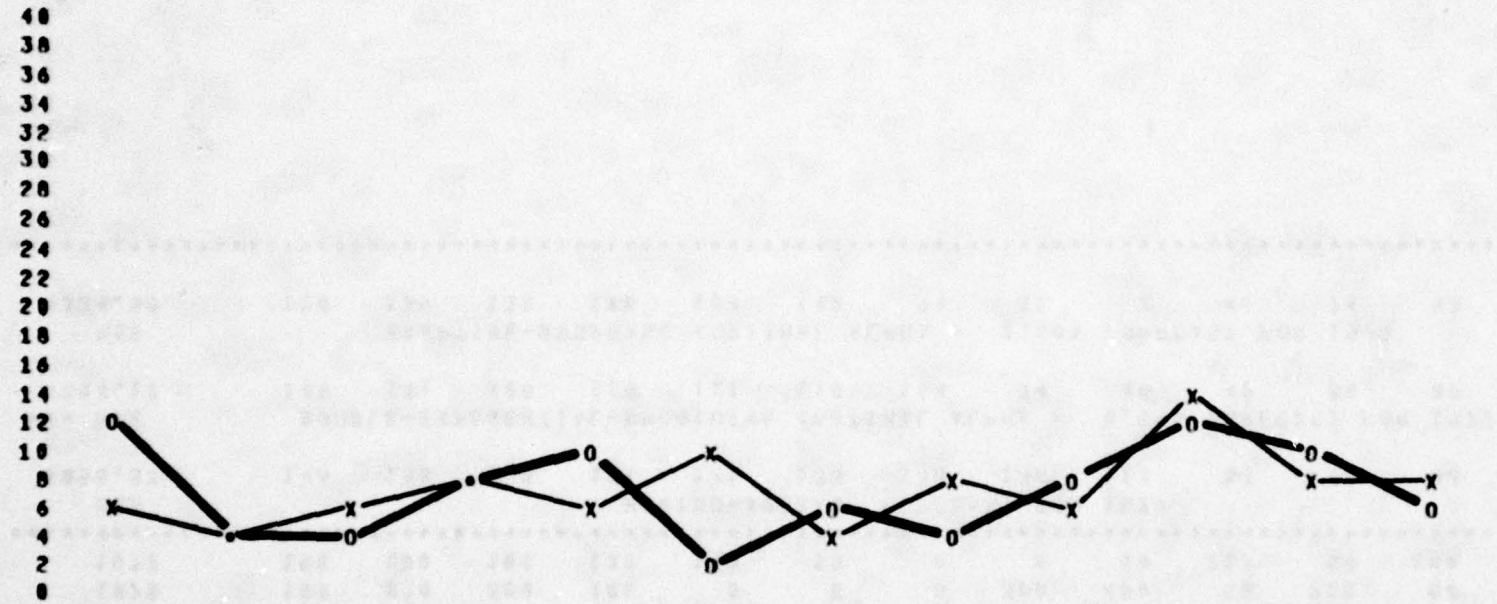
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009615584

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	168	118	188	284	174	283	132	248	192	372	252	228
1977	114	48	48	84	96	24	68	42	84	108	96	68

MSE					MOVING-AVERAGE FORECAST FOR 1977							
10201.58	212	207	202	191	181	174	153	147	130	121	99	86

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
2618.83	231	125	55	49	81	95	31	57	44	88	105	97

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
2579.58	233	117	48	48	83	95	24	59	45	76	106	96



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

APPENDIX E

COMPUTER PRODUCTS, SEASONAL (WHITEMAN)

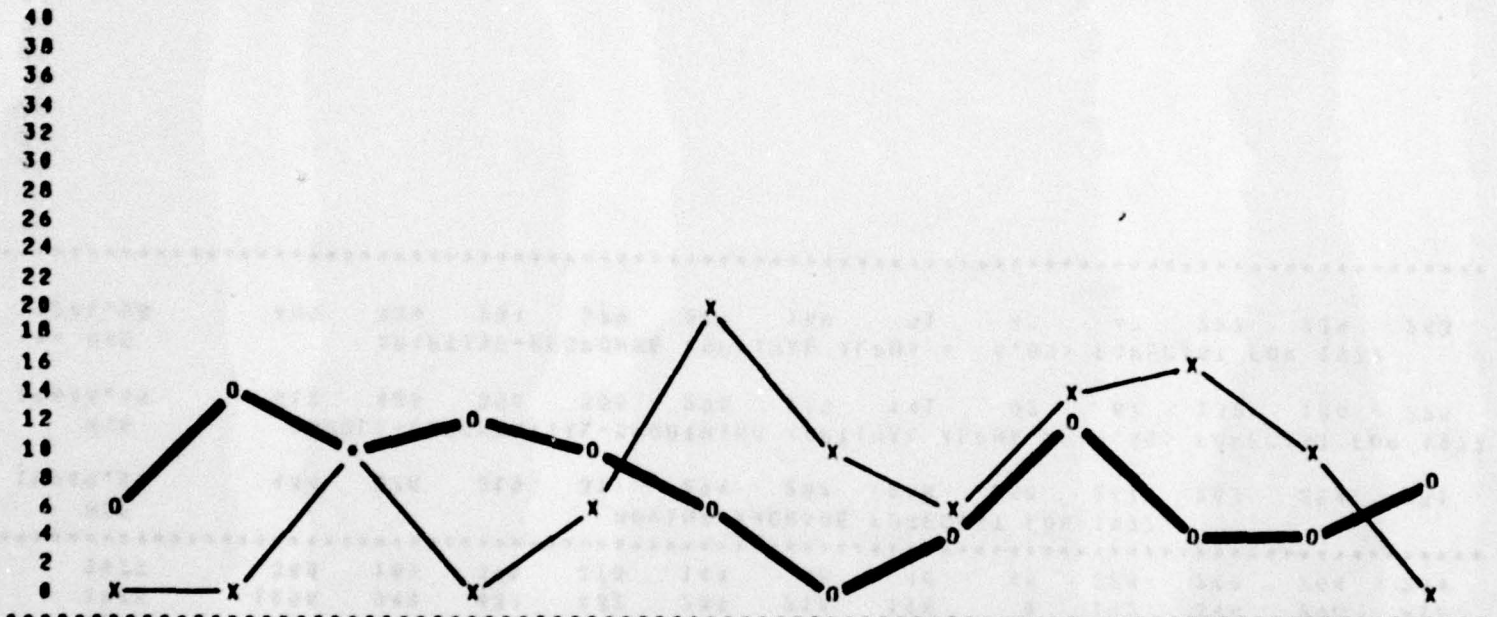
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008636197

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	14	0	9	24	13	8	18	19	12	0
1977	6	12	9	10	8	5	0	4	11	4	4	7

MSE	MOVING-AVERAGE FORECAST FOR 1977											
20.42	10	10	11	11	12	12	10	9	9	8	7	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
11.75	5	6	6	6	6	6	6	6	6	6	6	6

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
12.92	7	6	5	11	9	9	8	6	0	3	6	4



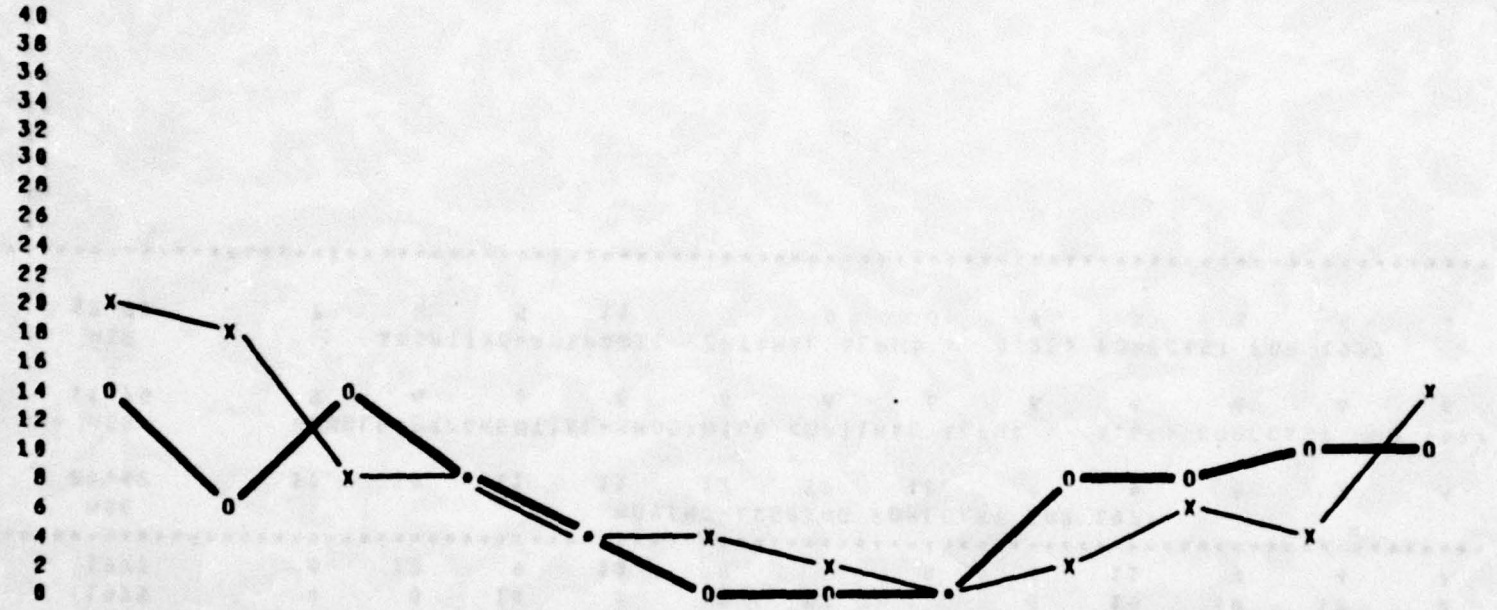
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008648765

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1056	948	432	432	284	216	148	0	192	396	296	816
1977	384	185	391	216	144	48	48	48	228	240	264	264

MSE	MOVING-AVERAGE FORECAST FOR 1977											
18969.58	434	378	315	312	294	282	268	268	264	267	254	251

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
19846.35	512	486	356	355	296	225	141	92	67	132	186	225

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
12241.58	489	384	284	379	287	169	51	48	47	227	239	263



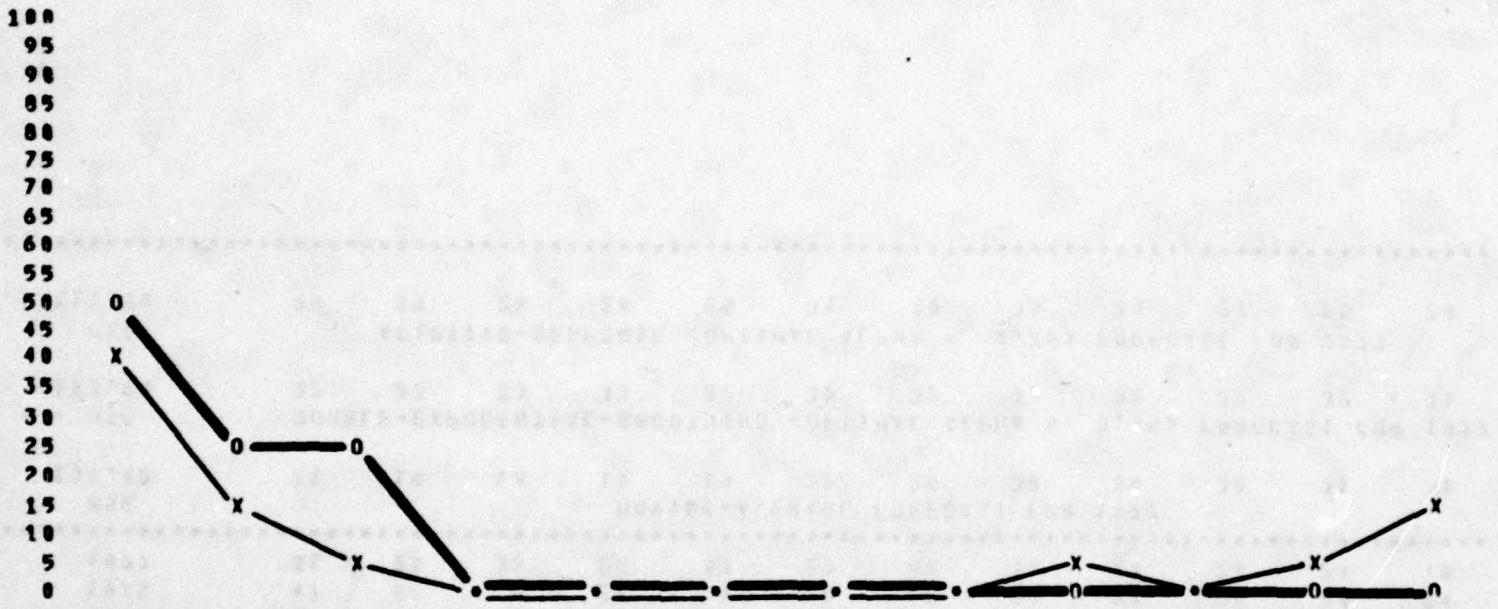
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505808796269

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	5	2	1	0	0	0	0	0	1	0	1	2
1977	2	1	1	0	0	0	0	0	0	0	0	0

MSE					MOVING-AVERAGE FORECAST FOR 1977							
0.83	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
0.17	2	2	1	1	0	0	0	0	0	0	0	0

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
0.17	1	1	1	1	1	0	0	0	0	0	0	0



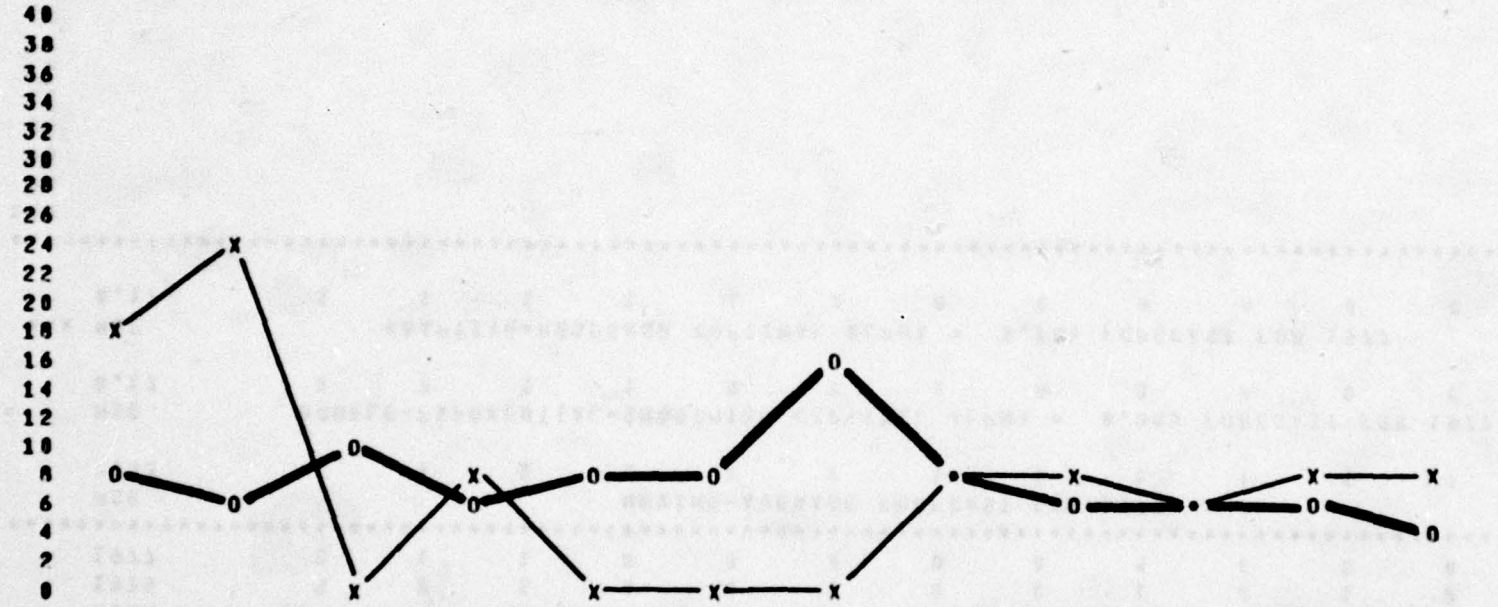
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505000002246

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	47	61	8	24	8	0	8	24	24	18	24	24
1977	31	25	36	26	33	29	60	30	24	24	24	18

MSE	MOVING-AVERAGE FORECAST FOR 1977											
195.42	21	19	16	19	19	22	25	30	30	30	31	31

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
107.08	33	33	33	33	32	32	32	32	32	32	32	31

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
111.50	22	29	25	26	25	31	29	33	30	27	25	24



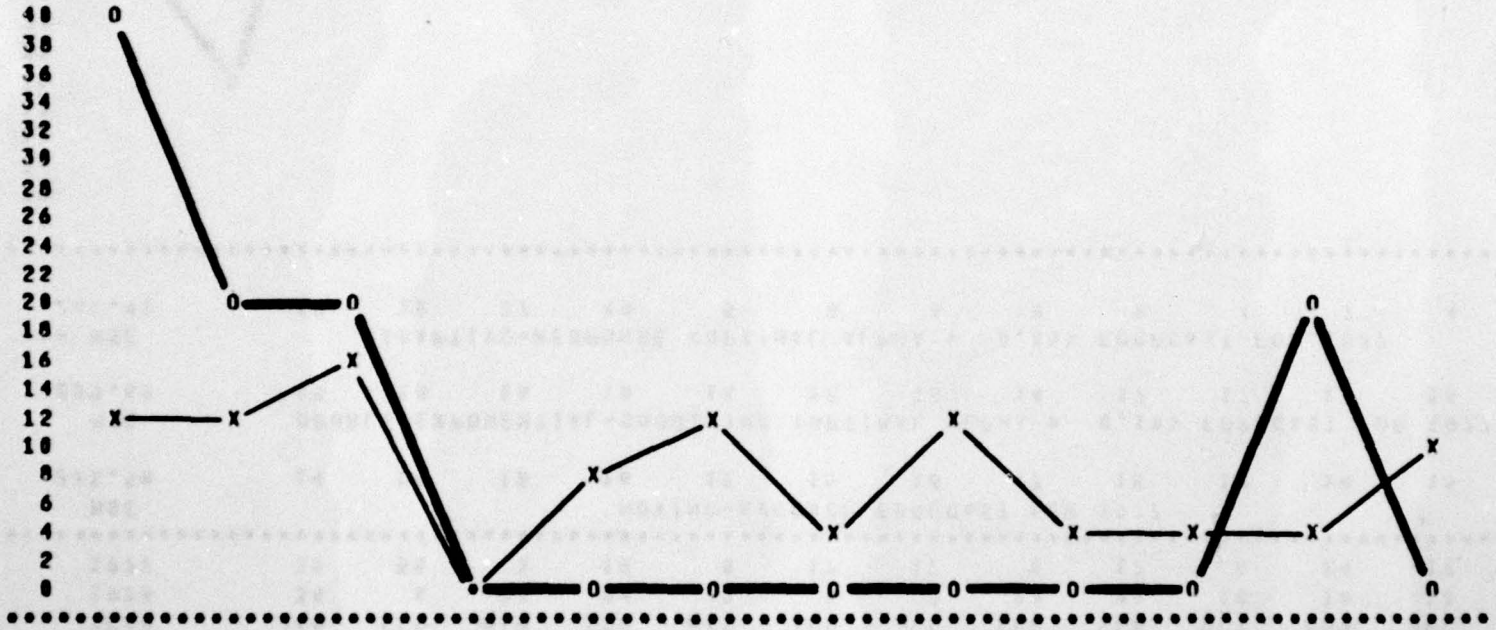
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001161038

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	9	9	12	0	6	9	3	10	3	3	3	8
1977	2	1	1	0	0	0	0	0	0	0	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
11.00	6	6	5	4	4	4	3	3	2	2	1	1

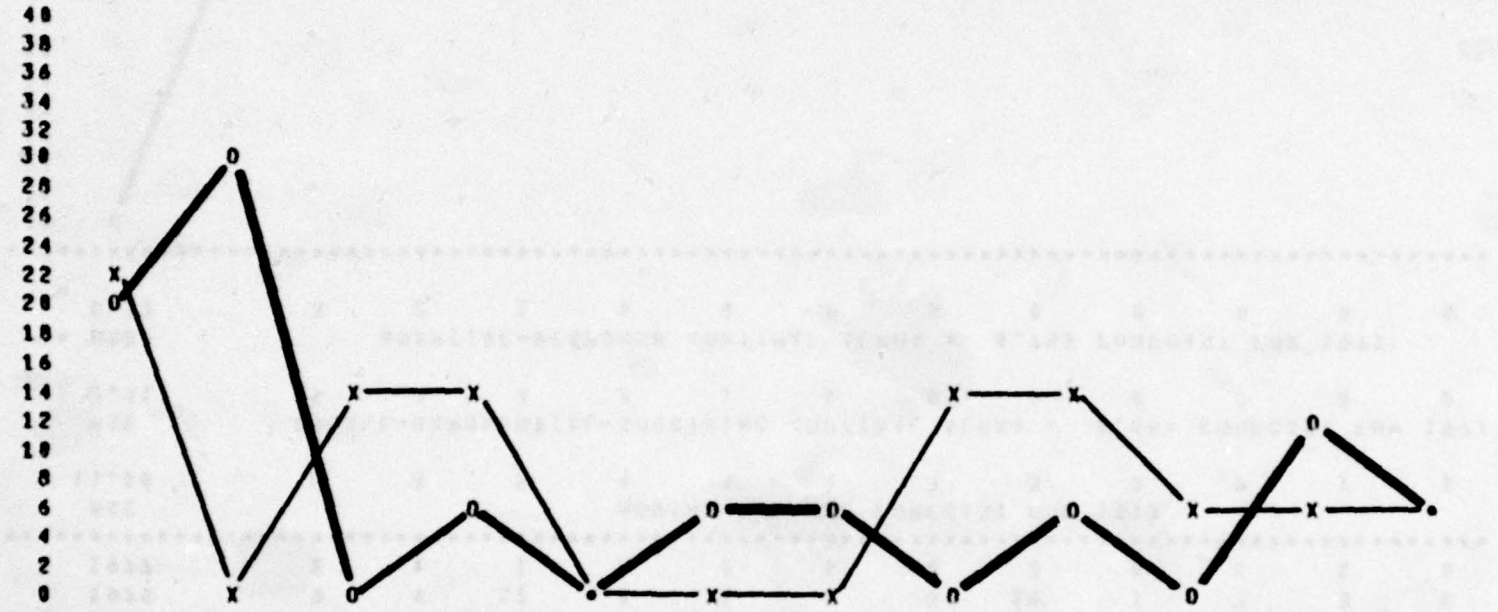
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
2.81	5	4	3	2	1	0	0	0	0	0	0	0

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
0.33	3	2	1	1	0	0	0	0	0	0	0	0



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001335888

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	36	0	24	24	0	0	0	24	24	10	10	10
1977	36	55	3	12	0	12	12	0	12	0	24	12
MSE	MOVING-AVERAGE FORECAST FOR 1977											
271.58	14	14	18	16	15	15	16	17	15	14	14	15
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
255.67	18	18	18	18	18	18	18	18	17	17	16	16
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
247.42	12	10	27	49	5	8	6	8	8	4	7	4



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

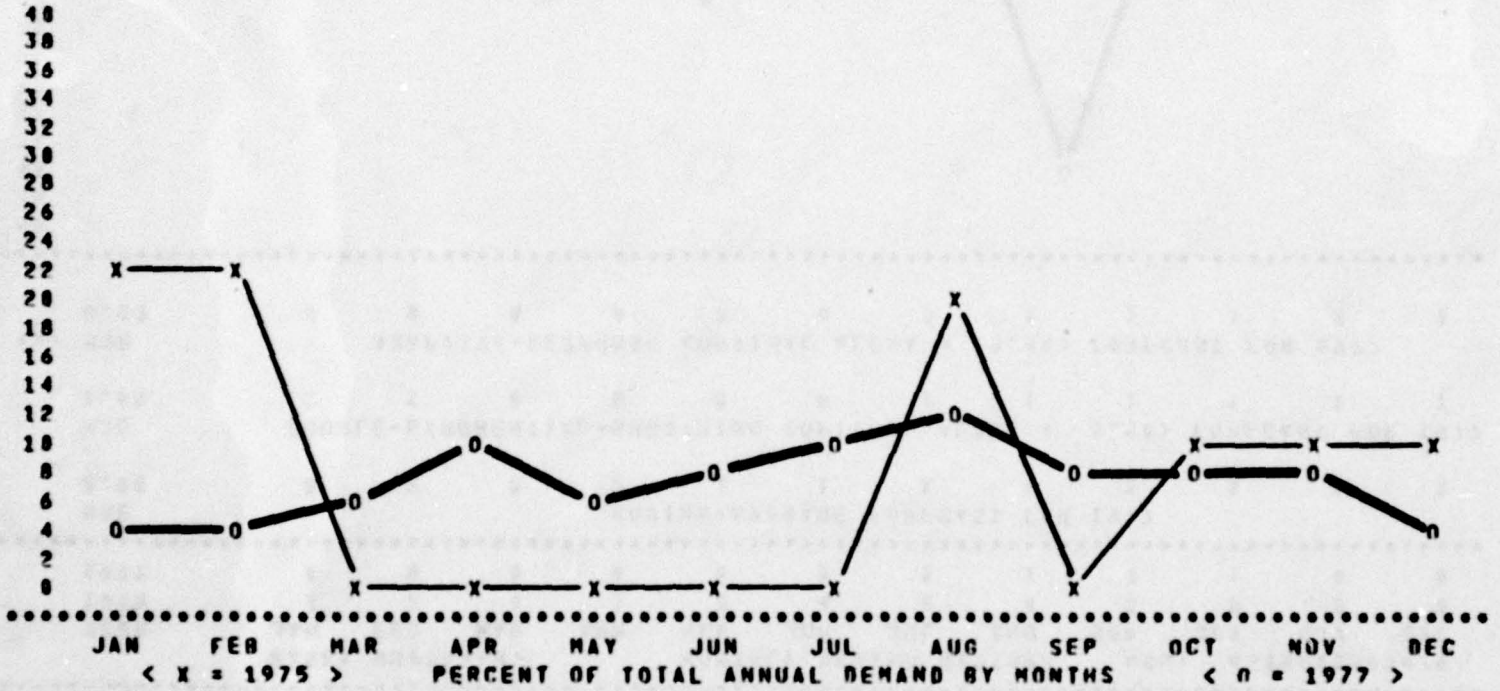
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001596625

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	18	18	8	8	8	8	8	17	8	8	9	8
1977	6	6	8	12	9	11	14	15	10	11	10	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
14.50	7	6	5	5	6	7	8	9	9	10	10	10

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.90) FORECAST FOR 1977											
7.82	8	6	6	8	11	9	11	13	15	11	11	10

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.90) FORECAST FOR 1977											
7.25	8	6	6	7	11	9	10	13	14	10	10	9



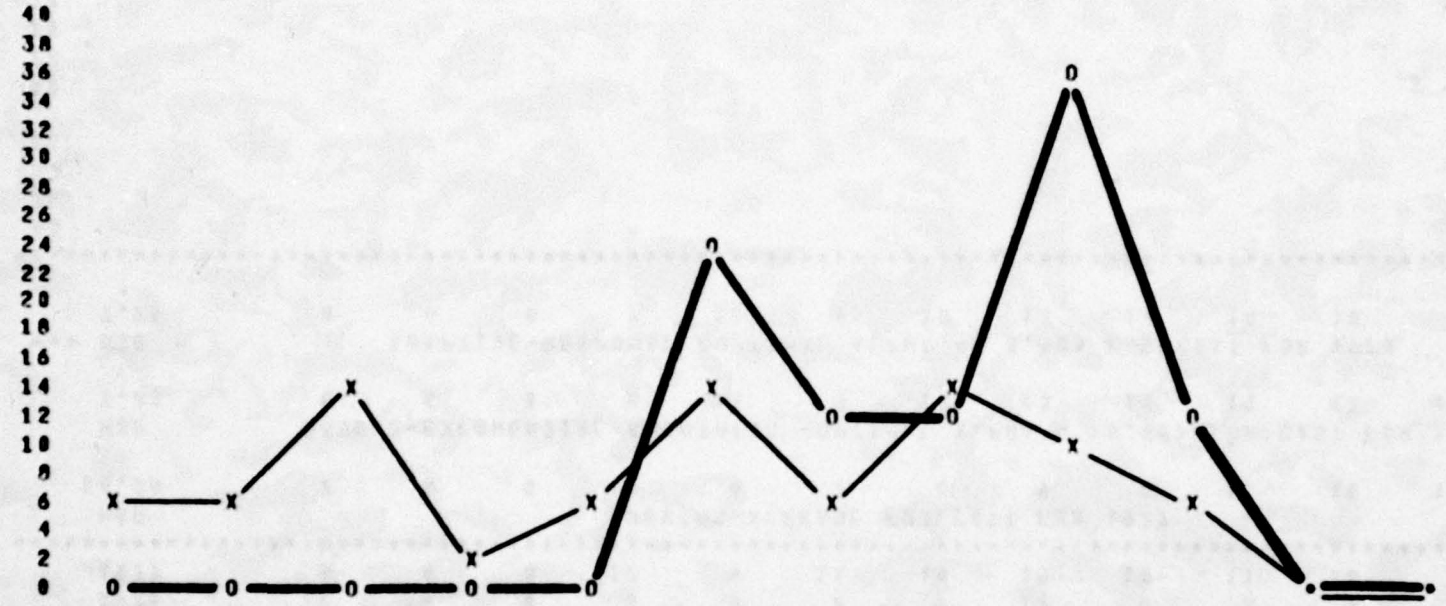
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001598475

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	2	4	1	2	4	2	4	3	2	0	0
1977	0	0	0	0	0	2	1	1	3	1	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.00	2	2	2	2	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
1.00	1	1	0	0	0	0	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
0.83	0	0	0	0	0	0	0	1	1	1	2	1



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

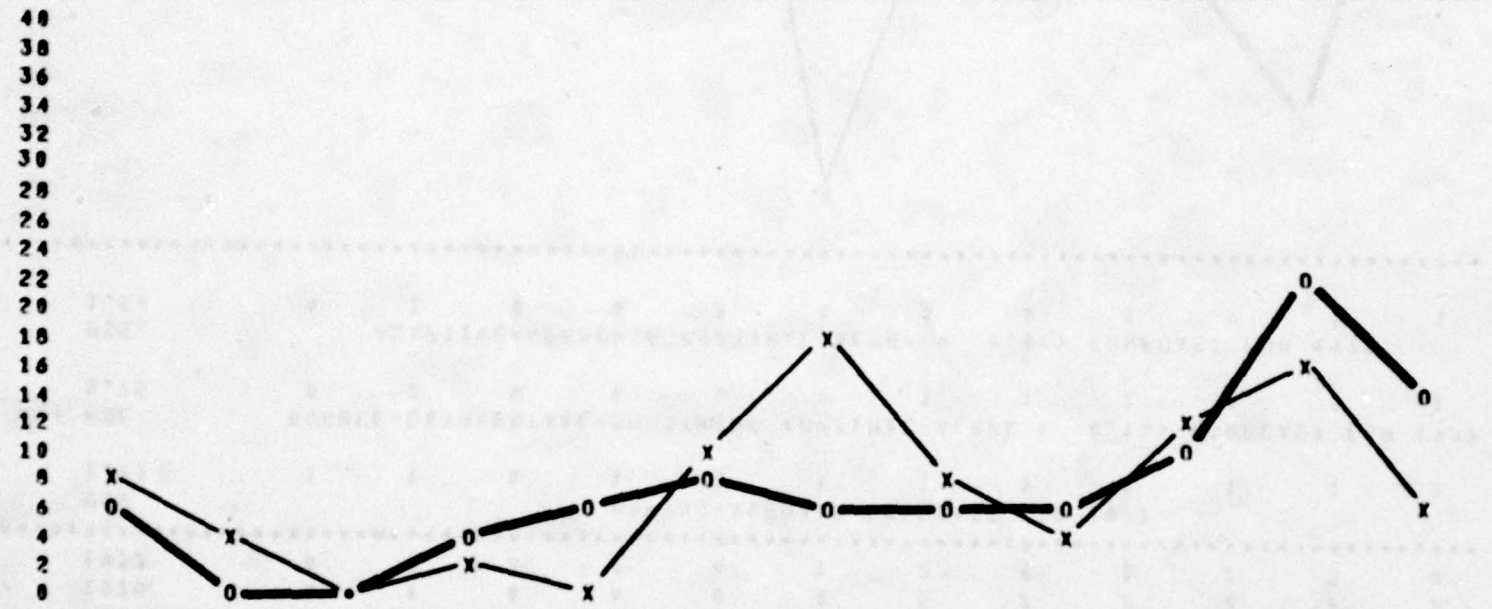
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505002998279

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	6	0	4	0	14	24	12	6	16	20	8
1977	5	0	0	4	6	7	6	5	6	8	18	12

MSE	MOVING-AVERAGE FORECAST FOR 1977											
37.42	10	10	9	9	9	10	9	8	7	7	6	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
17.88	9	5	1	0	4	6	7	6	5	6	8	17

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
18.33	8	5	0	0	3	5	6	6	5	5	7	17



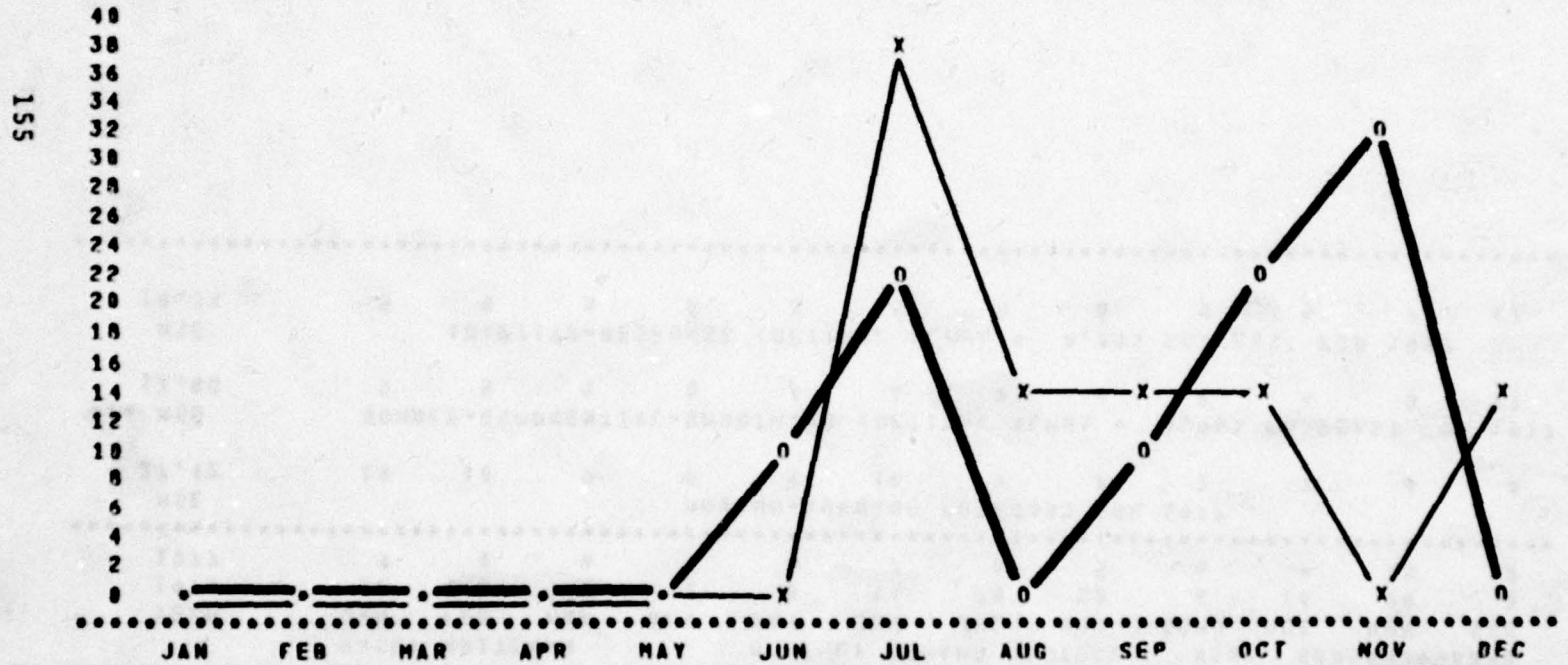
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505002998354

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	0	5	2	2	2	0	2
1977	0	0	0	0	0	1	2	0	1	2	3	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.00	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
0.75	0	0	0	0	0	0	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
1.50	0	1	0	0	0	0	0	0	1	0	0	1



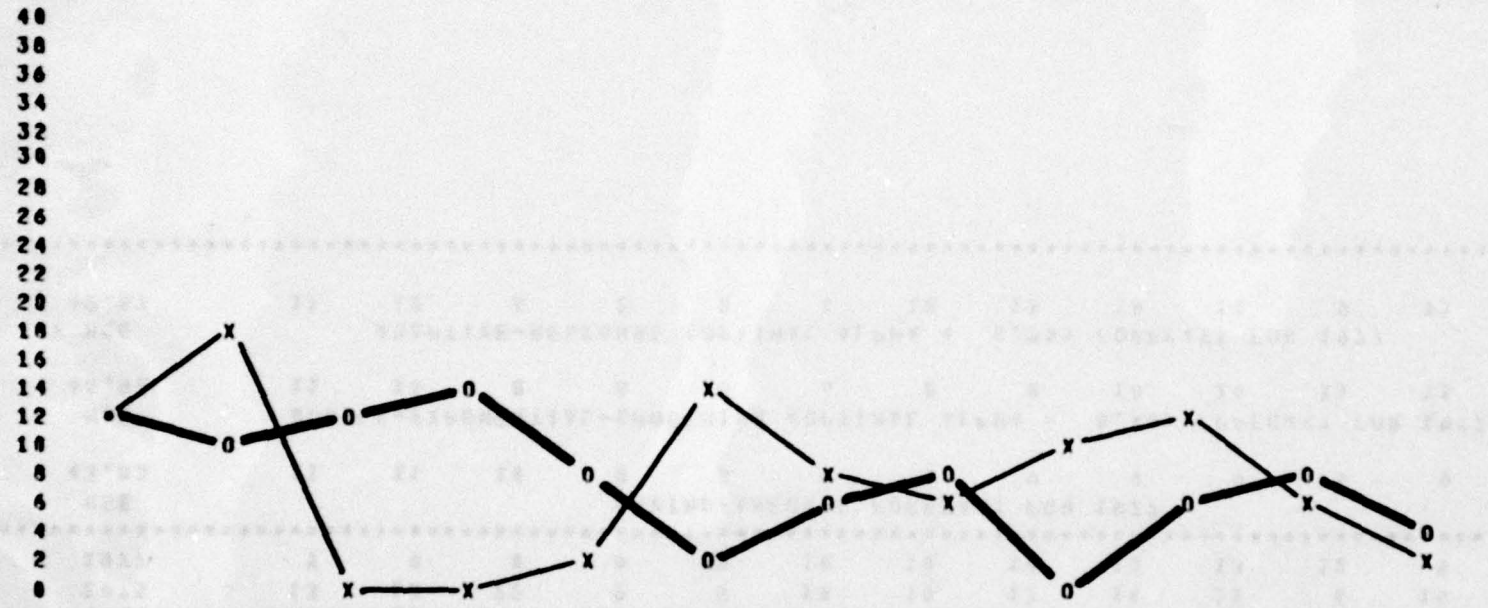
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005596859

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	22	34	0	0	4	26	16	12	18	22	12	6
1977	18	17	18	21	14	5	10	13	2	11	13	7

MSE	MOVING-AVERAGE FORECAST FOR 1977											
39.33	14	14	13	14	16	17	15	14	15	13	12	12

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
28.92	14	14	15	16	17	17	14	13	12	10	10	10

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
25.92	12	7	17	17	17	20	14	6	9	10	2	9



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

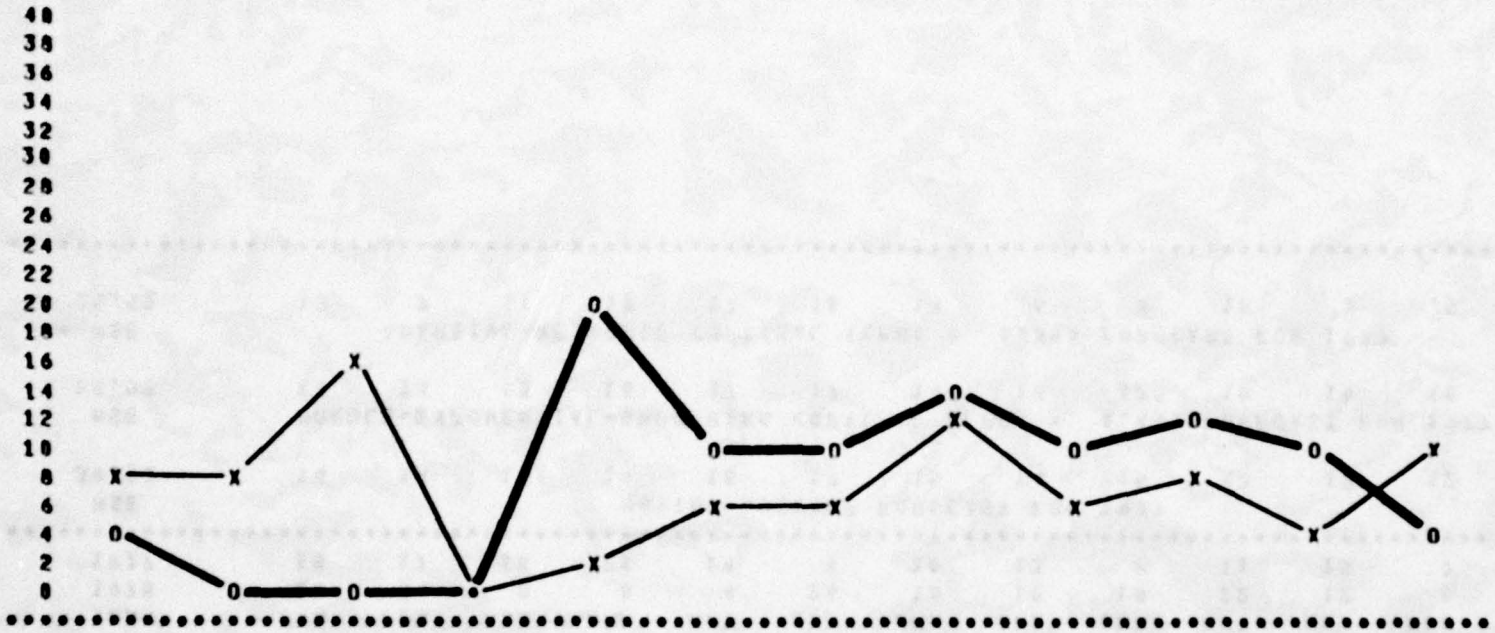
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005760842

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	13	13	22	2	5	10	10	17	10	11	8	15
1977	5	0	0	0	20	10	10	14	10	13	10	5

MSE	MOVING-AVERAGE FORECAST FOR 1977											
43.83	11	11	10	8	8	9	9	9	9	9	9	9

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
46.92	11	10	8	6	5	6	8	8	10	10	11	11

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
42.67	11	12	6	2	0	0	10	10	10	10	9	11



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

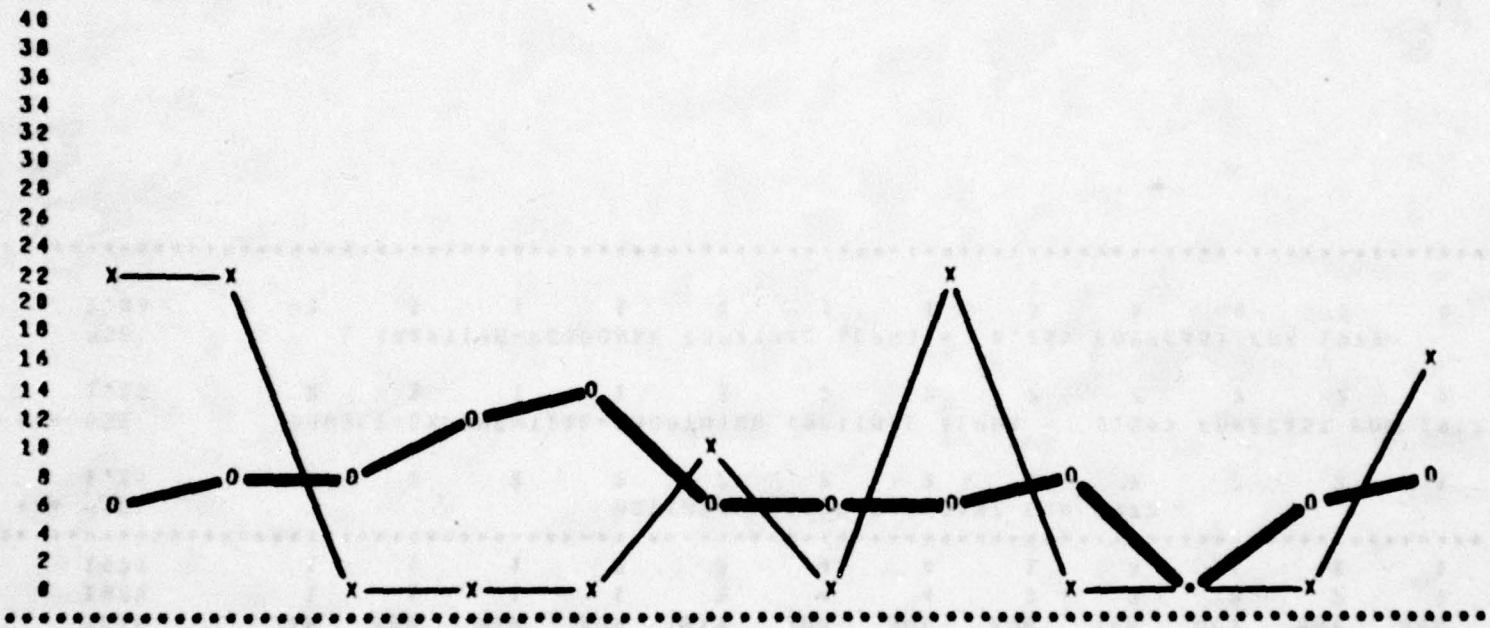
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005769128

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	12	0	0	0	6	0	12	0	0	0	9
1977	18	23	24	30	36	18	18	18	21	0	15	24

MSE	MOVING-AVERAGE FORECAST FOR 1977											
282.67	4	5	6	8	10	13	14	16	16	18	18	19

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.90) FORECAST FOR 1977											
108.69	7	16	22	24	29	35	21	18	19	20	4	13

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.50) FORECAST FOR 1977											
99.33	1	16	22	23	29	35	18	17	17	17	9	13



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005024868

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	1	1	1	2	4	4	2	3	2	2	0
1977	1	1	1	2	2	4	0	1	3	1	1	1

MOVING-AVERAGE FORECAST FOR 1977

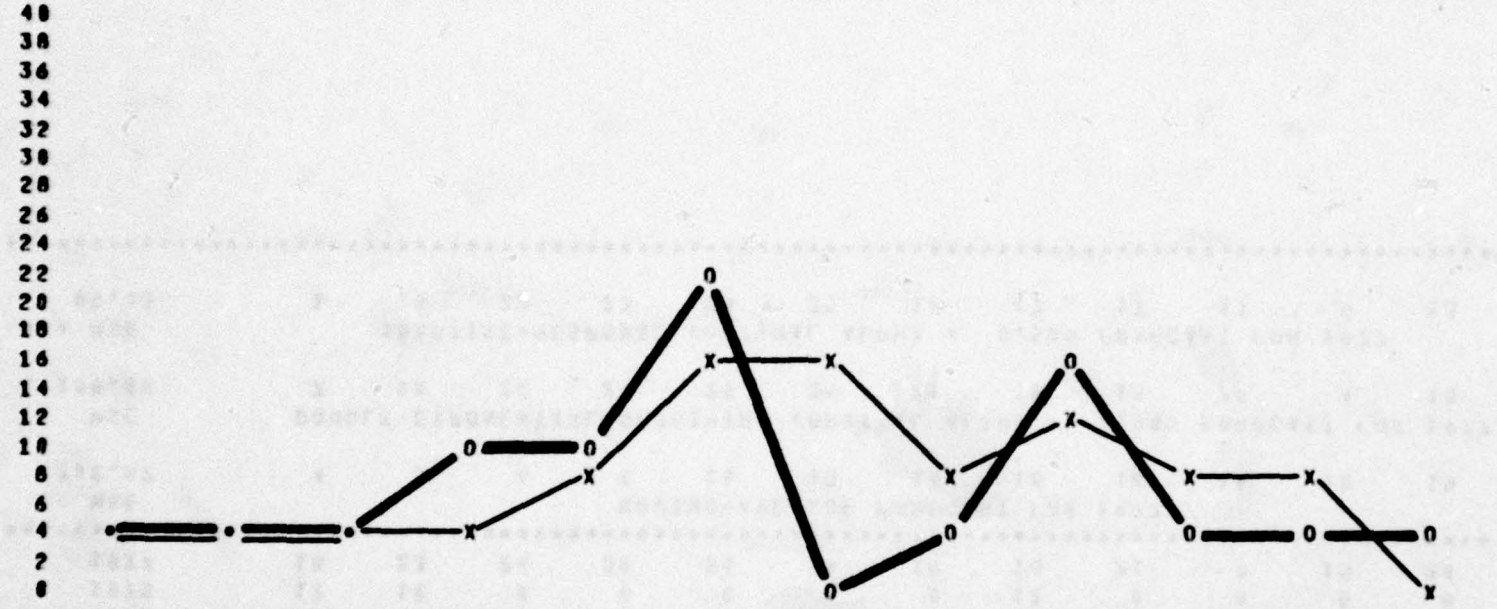
MSE												
1.25	2	2	2	2	2	2	2	2	2	2	2	1

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977

MSE												
1.25	2	1	1	1	1	2	2	2	2	2	2	1

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE												
1.83	1	1	1	1	1	1	1	3	0	0	0	0



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006198737

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	0	3	2	2	2	2	3	2	0	1	1
1977	3	3	1	2	1	2	2	1	2	1	2	2

*** MSE MOVING-AVERAGE FORECAST FOR 1977

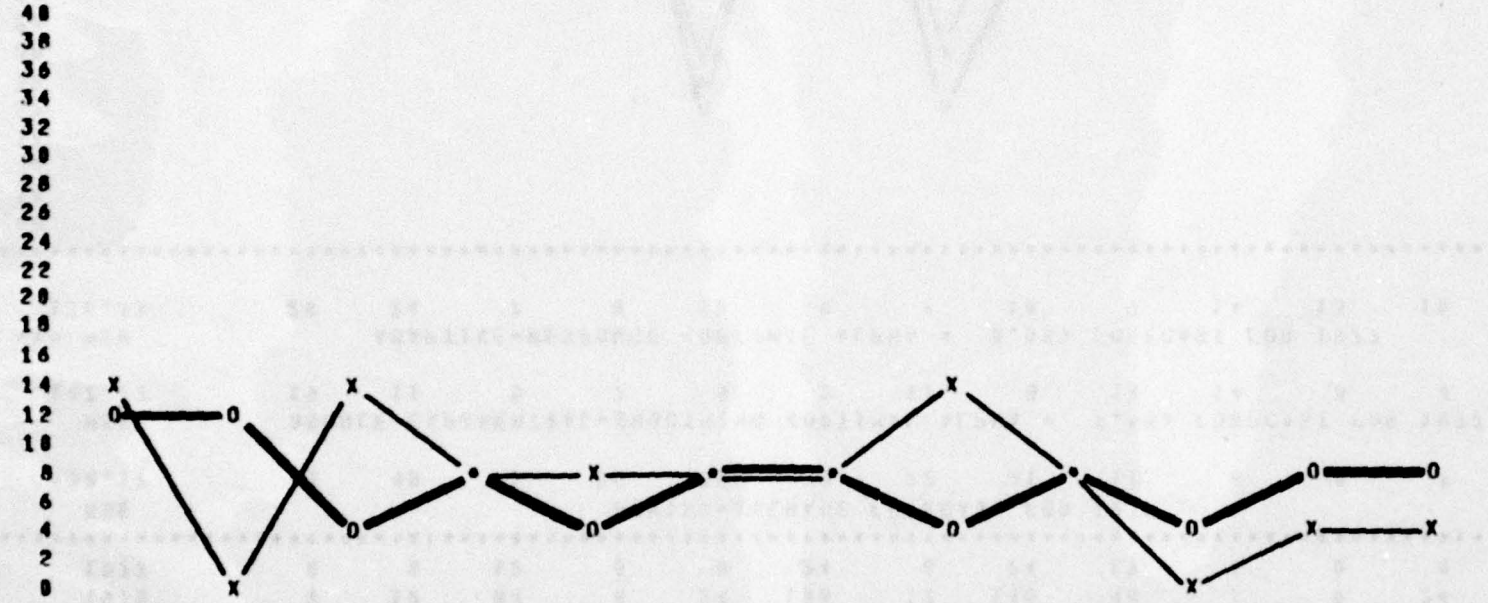
MSE												
0.50	2	2	2	2	2	2	2	2	2	2	2	2

*** MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

MSE												
0.50	2	2	2	2	2	2	2	2	2	2	2	2

MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

MSE												
1.42	0	2	2	1	1	1	1	1	1	1	1	1



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

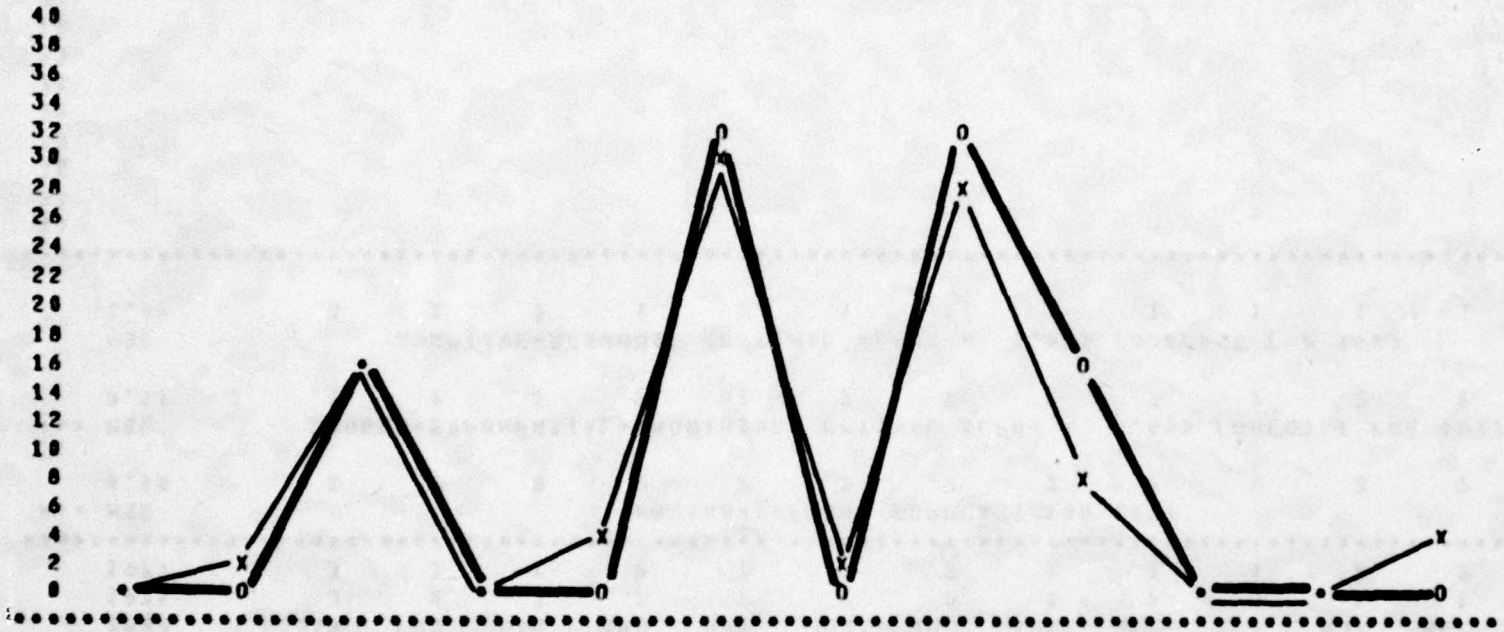
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006561466

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	12	84	0	24	156	12	148	48	0	0	24
1977	0	0	12	0	0	24	0	24	12	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
632.17	42	42	41	35	35	33	22	21	11	8	8	8

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
147.77	19	11	5	7	5	2	11	8	14	14	8	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
136.33	20	24	7	8	10	9	4	18	9	14	13	10



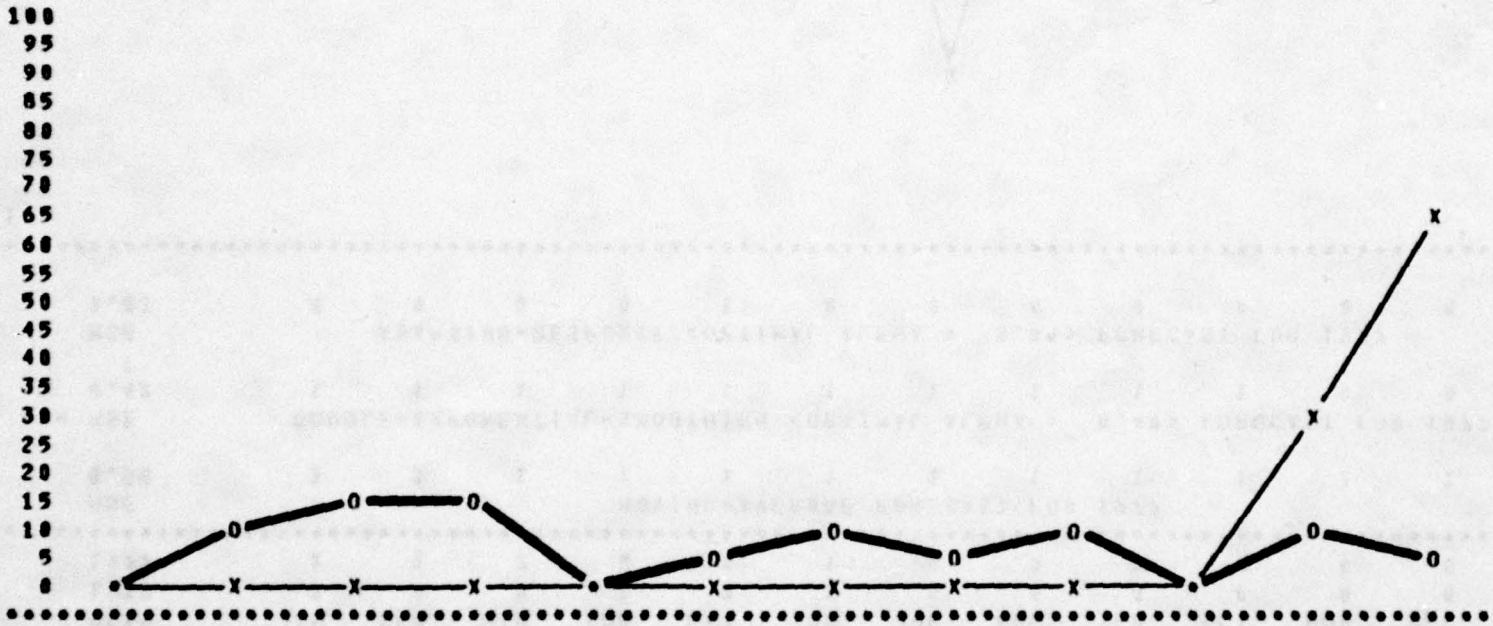
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006874849

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	0	0	0	0	0	3	6
1977	0	2	3	3	0	1	2	1	2	0	2	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.42	1	1	1	1	1	1	2	2	2	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.20) FORECAST FOR 1977											
1.17	0	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.90) FORECAST FOR 1977											
5.00	6	0	1	2	2	0	0	1	1	1	0	1



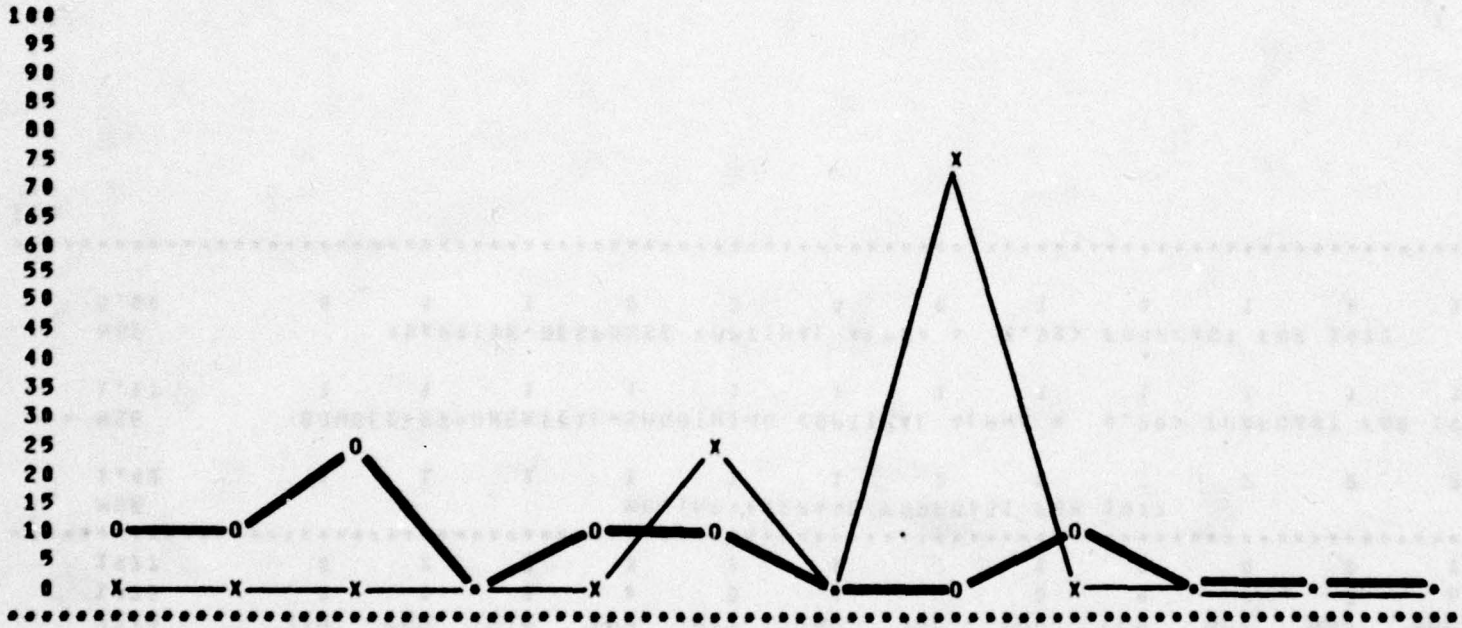
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006874053

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	2	0	6	0	0	0	0
1977	1	1	2	0	1	1	0	0	1	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.58	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
0.42	1	1	1	1	1	1	1	1	1	1	0	0

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
0.83	0	0	0	0	1	0	0	0	0	0	0	0



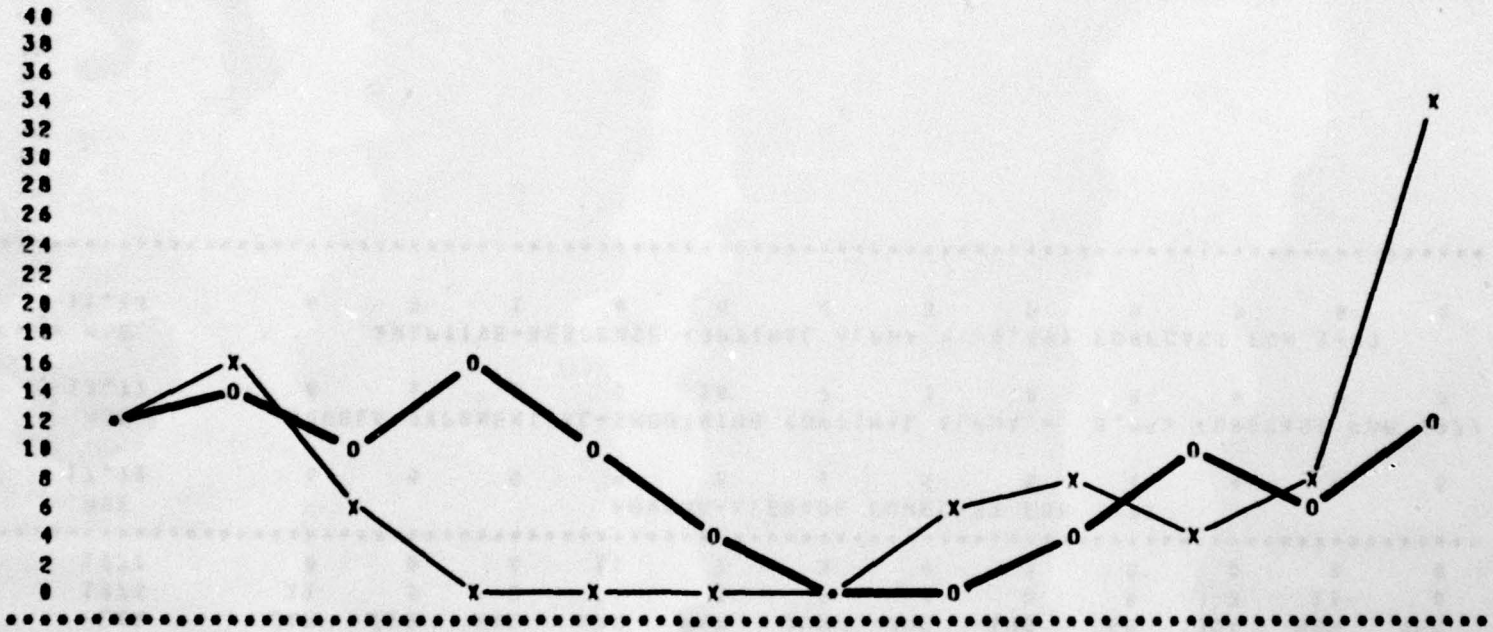
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505806878285

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	10	12	5	0	0	0	0	5	6	4	6	25
1977	6	7	5	8	5	2	0	0	2	5	3	6

MSE					MOVING-AVERAGE FORECAST FOR 1977							
12.58	4	6	5	5	6	6	7	7	6	6	6	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
11.08	7	8	8	8	8	7	7	5	4	4	3	3

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
7.58	7	19	6	6	5	5	4	2	0	0	1	3



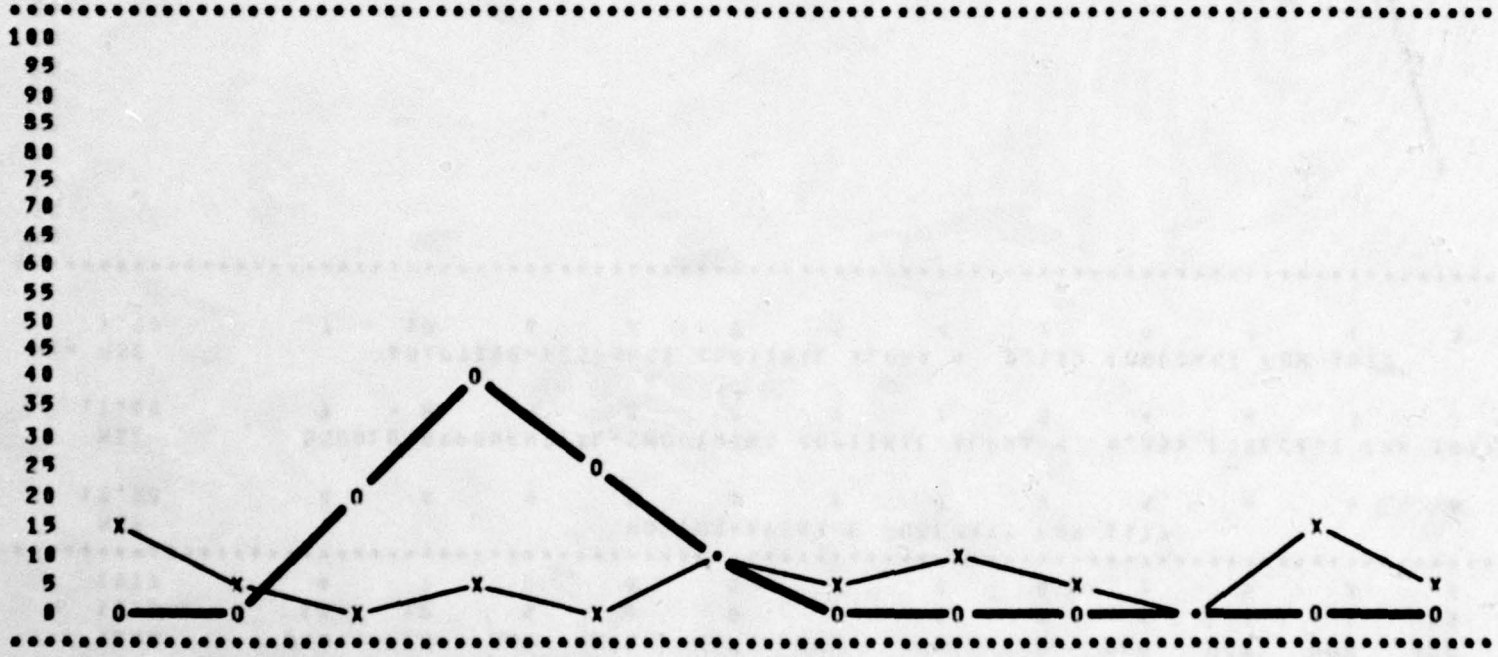
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505007219121

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	11	5	2	4	3	9	4	8	5	3	11	6
1977	0	0	6	11	7	3	0	0	0	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
17.92	6	5	5	5	6	6	5	5	4	4	4	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
12.77	6	1	0	5	10	7	3	0	0	0	0	0

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977											
11.83	6	3	1	4	6	6	3	2	0	0	0	0



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505007636821

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	1	2	1	0	0	0	0
1977	1	2	2	2	0	0	0	0	1	0	2	0

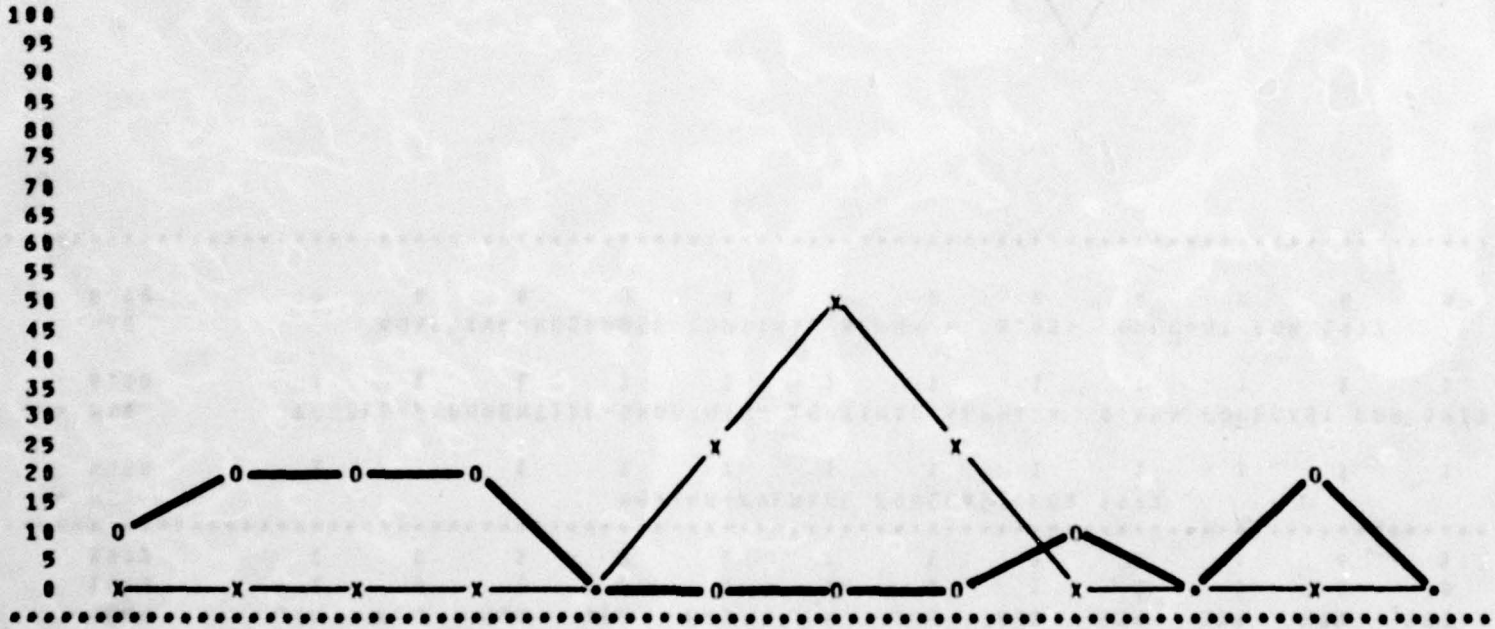
*** MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.17	0	0	1	1	1	1	1	1	1	1	1	1

*** MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977

1.17	0	0	1	1	1	1	1	1	1	1	1	1

*** MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

1.17	0	0	0	1	1	1	0	0	0	0	0	0



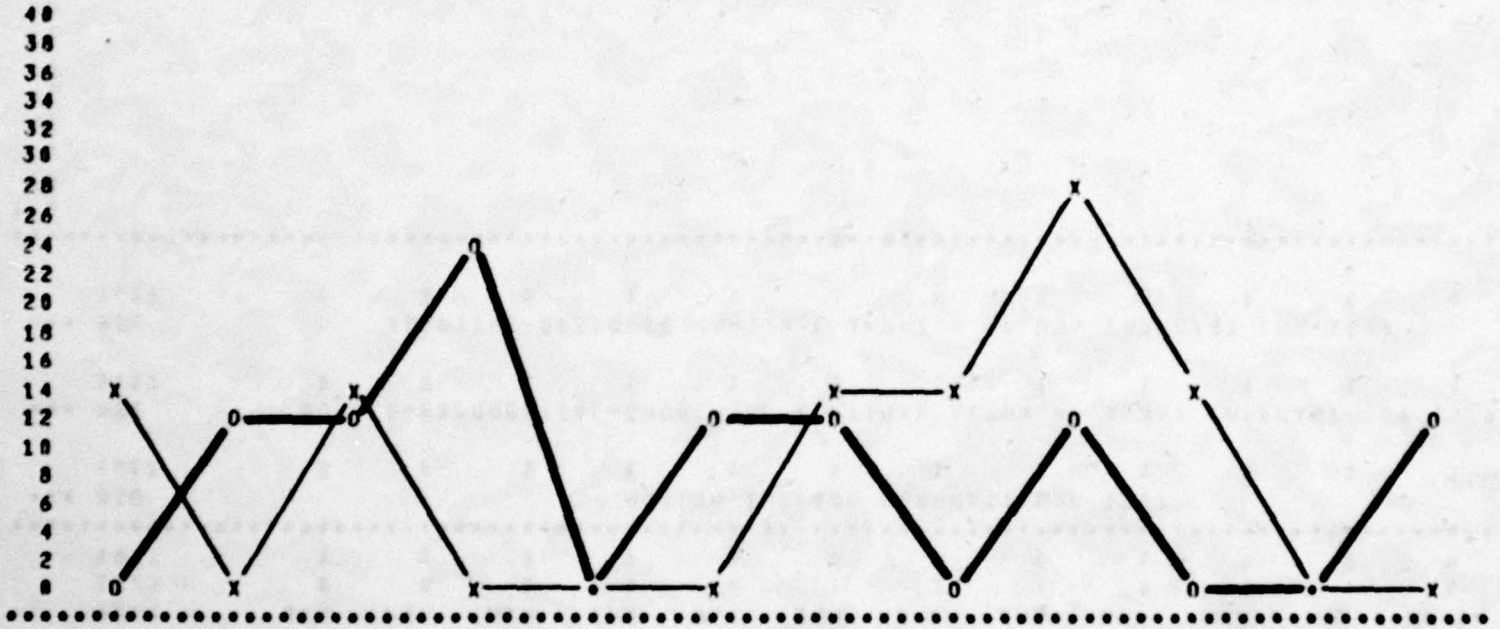
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505007643366

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	0	1	0	0	0	1	1	2	1	0	0
1977	0	1	1	2	0	1	1	0	1	0	0	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.50	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
0.50	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
0.92	0	0	0	0	0	1	0	0	0	0	0	0



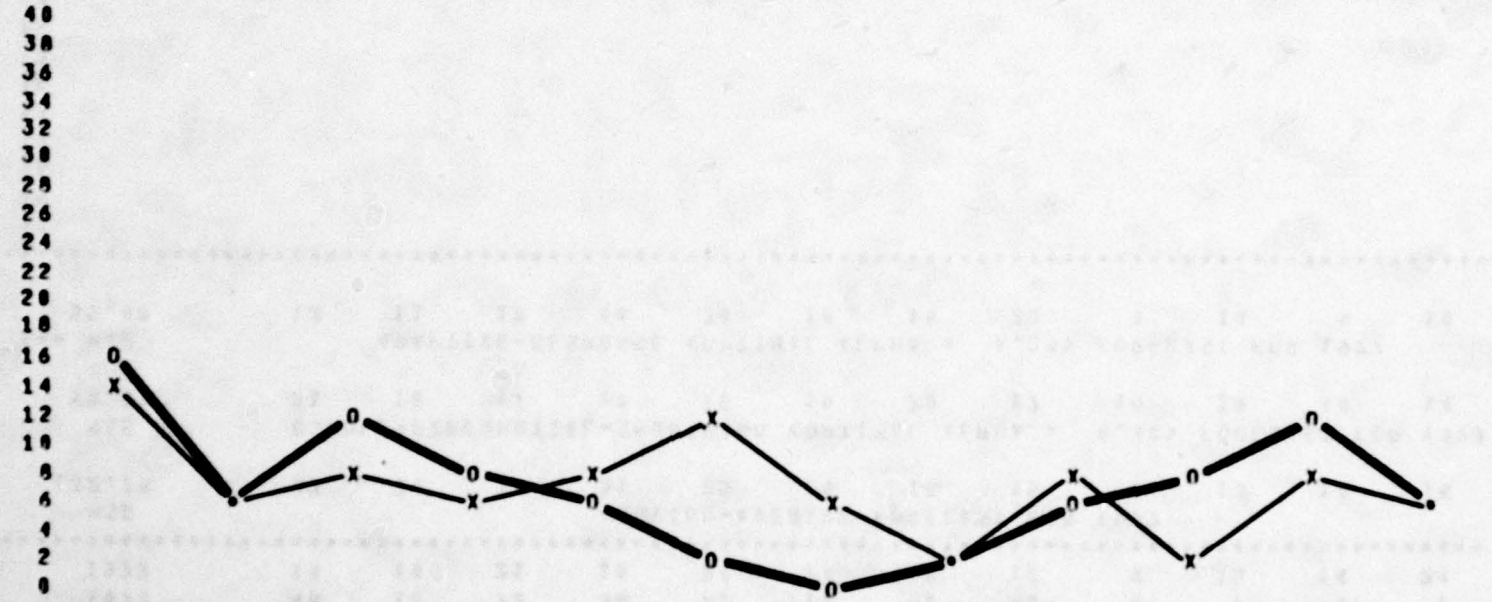
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505807826761

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	150	66	96	77	79	120	77	23	84	24	96	72
1977	208	84	156	116	96	36	12	48	96	108	156	96

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3078.50	88	85	87	92	95	96	89	84	86	87	94	99

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
2768.17	101	101	101	101	101	101	101	100	100	99	99	99

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.40) FORECAST FOR 1977											
3148.25	87	74	129	84	122	116	114	41	12	47	86	107



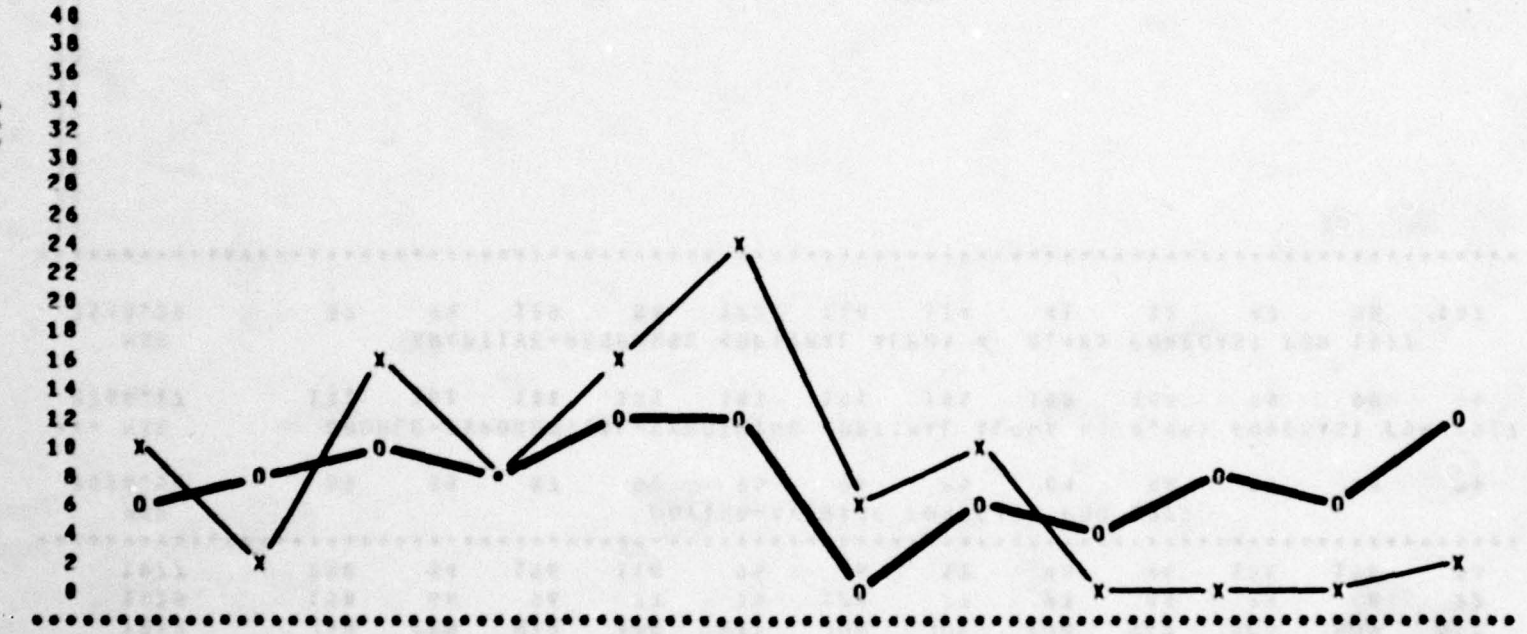
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008901299

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	48	12	72	36	72	112	32	48	0	0	0	12
1977	14	19	21	18	24	24	0	12	9	18	14	24

MSE					MOVING-AVERAGE FORECAST FOR 1977							
132.75	37	34	35	31	29	25	18	15	12	13	14	15

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
59.83	21	18	17	17	17	19	20	17	15	14	14	14

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
55.42	12	11	12	16	20	18	18	23	0	10	9	10



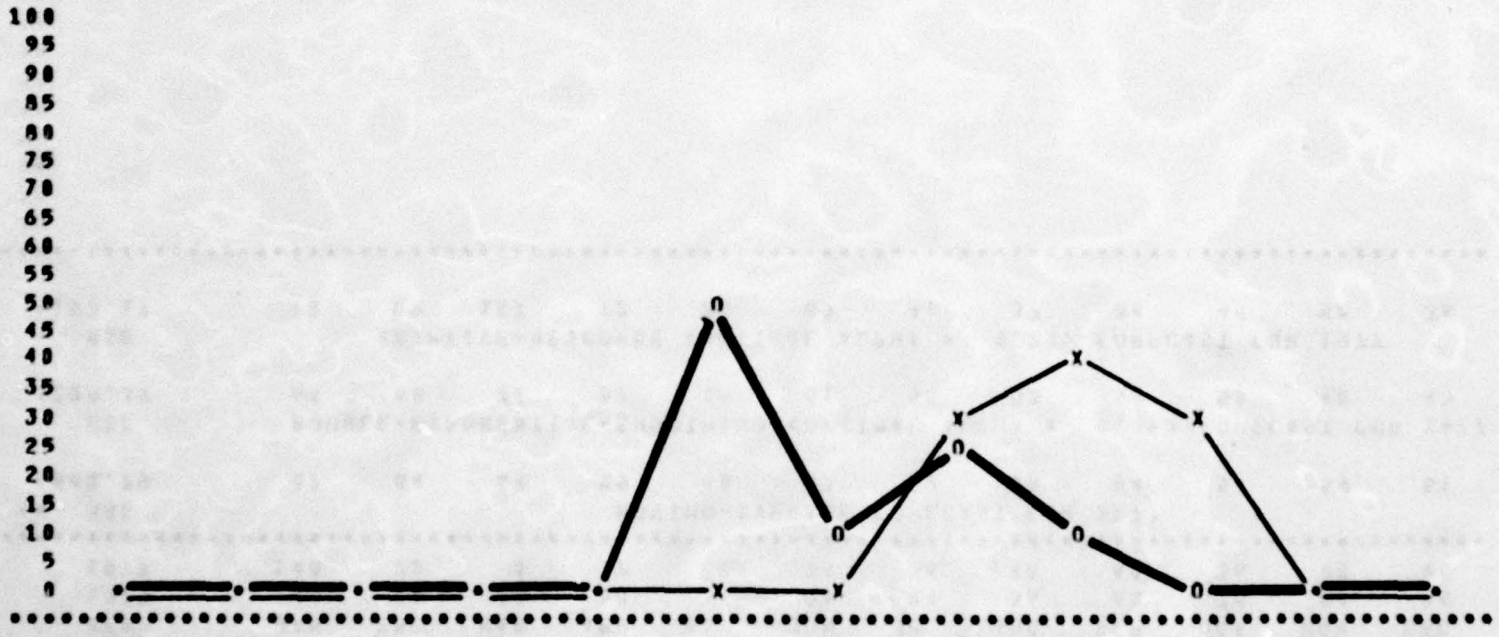
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008981573

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	0	0	6	0	6	0	0
1977	0	0	0	0	0	10	2	5	2	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
8.58	2	2	2	2	2	2	3	3	3	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
8.92	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
9.67	1	0	0	0	0	0	0	9	2	2	2	1



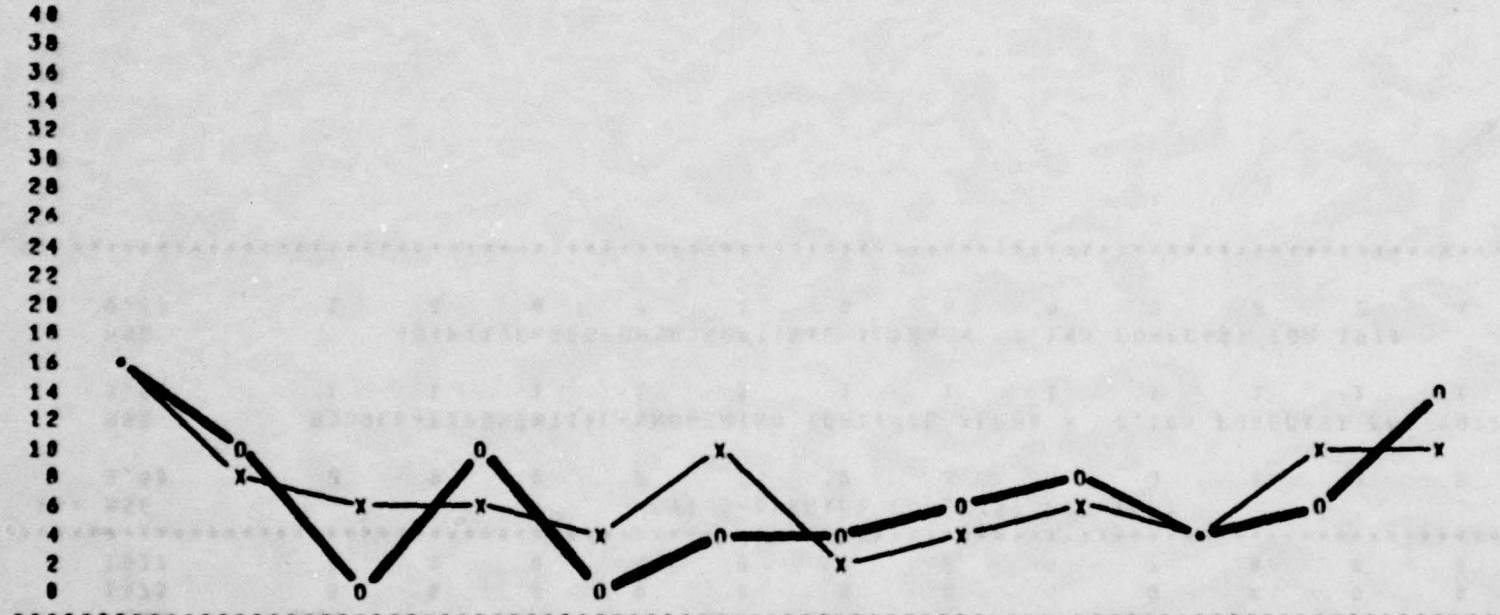
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008981657

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	144	72	60	60	36	96	24	36	60	36	84	96
1977	108	72	0	72	0	36	36	48	60	36	48	96

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1062.75	67	64	64	59	60	57	52	53	54	54	54	51

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
1229.33	64	68	70	67	65	61	56	53	50	50	48	48

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
1153.17	72	69	107	72	25	69	41	37	36	45	56	36



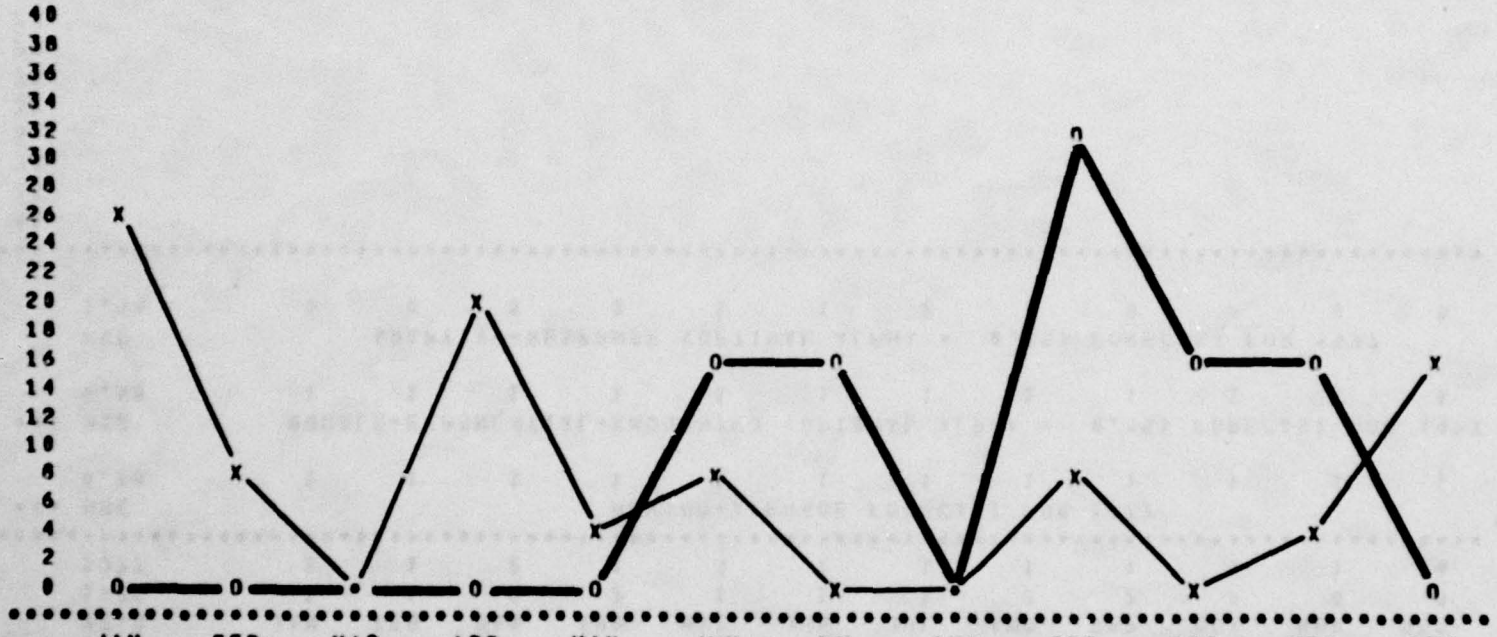
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 4505008901840

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	2	0	5	1	2	0	0	2	0	1	4
1977	0	0	0	0	0	1	1	0	2	1	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.92	2	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
0.67	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
0.58	0	3	0	0	0	0	0	0	0	0	1	1



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009040119

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	1	0	2	1	1	1	2	2	0	0	0
1977	1	1	2	1	3	0	1	1	1	1	1	0

••• MSE MOVING-AVERAGE FORECAST FOR 1977

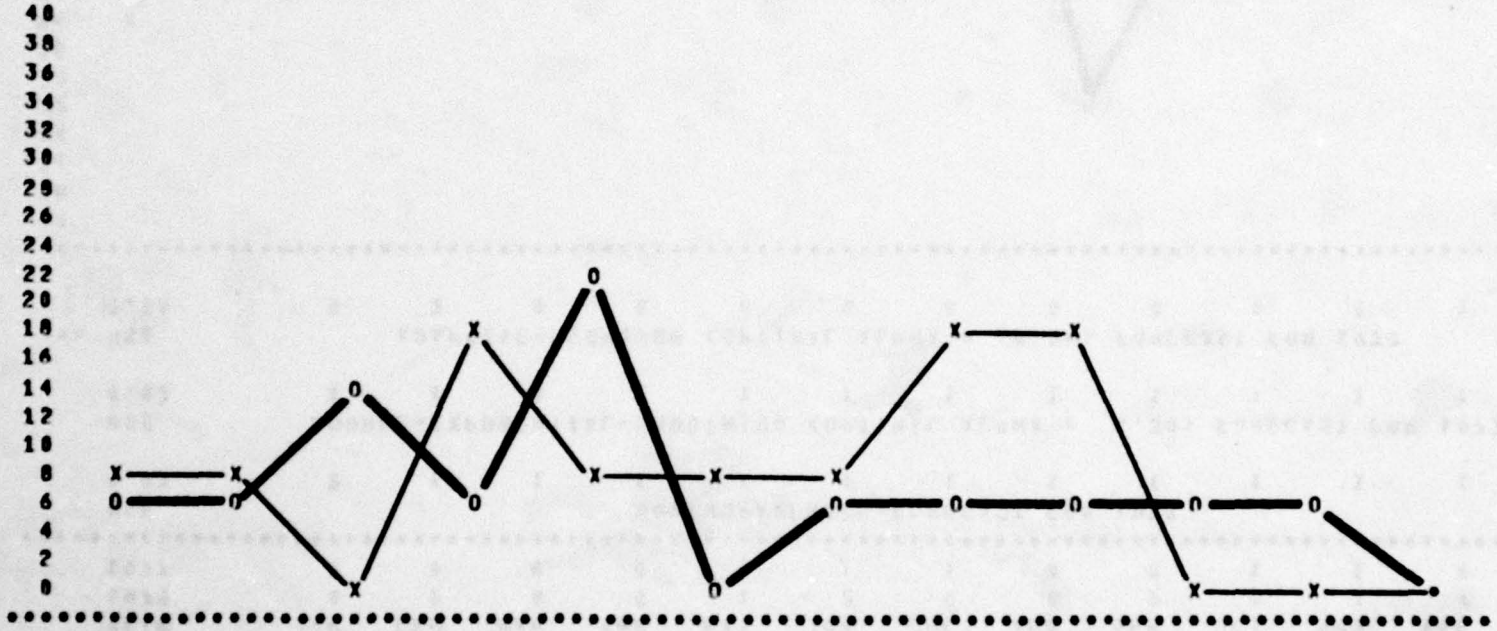
MSE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.50	1	1	1	1	1	1	1	1	1	1	1	1

••• MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

MSE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.50	1	1	1	1	1	1	1	1	1	1	1	1

MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.50	0	0	0	0	1	1	2	0	0	0	0	0



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009262241

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	24	18	20	12	0	48	18	66	120	36	66	48
1977	36	30	36	42	18	18	24	24	36	18	36	36

MSE	MOVING-AVERAGE FORECAST FOR 1977											
253.33	40	41	42	43	46	47	45	45	42	35	33	31

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
82.17	26	28	29	29	30	31	31	31	31	32	32	32

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
107.67	49	45	40	37	36	40	28	19	23	23	24	18

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

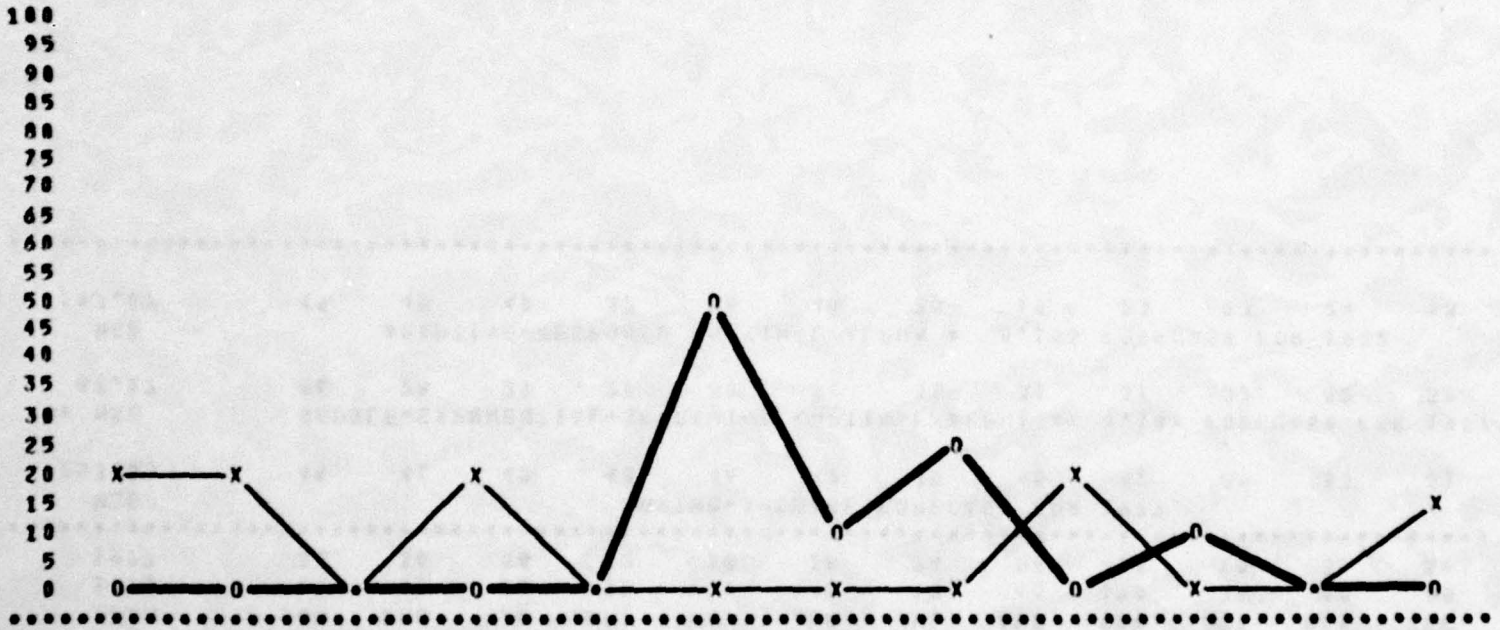
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009269089

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	4	0	6	0	0	0	0	6	0	0	5
1977	0	0	0	0	0	4	1	2	0	1	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.25	2	2	1	1	1	1	1	1	2	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
2.00	2	2	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.58	0	1	0	0	0	0	0	1	1	1	0	0



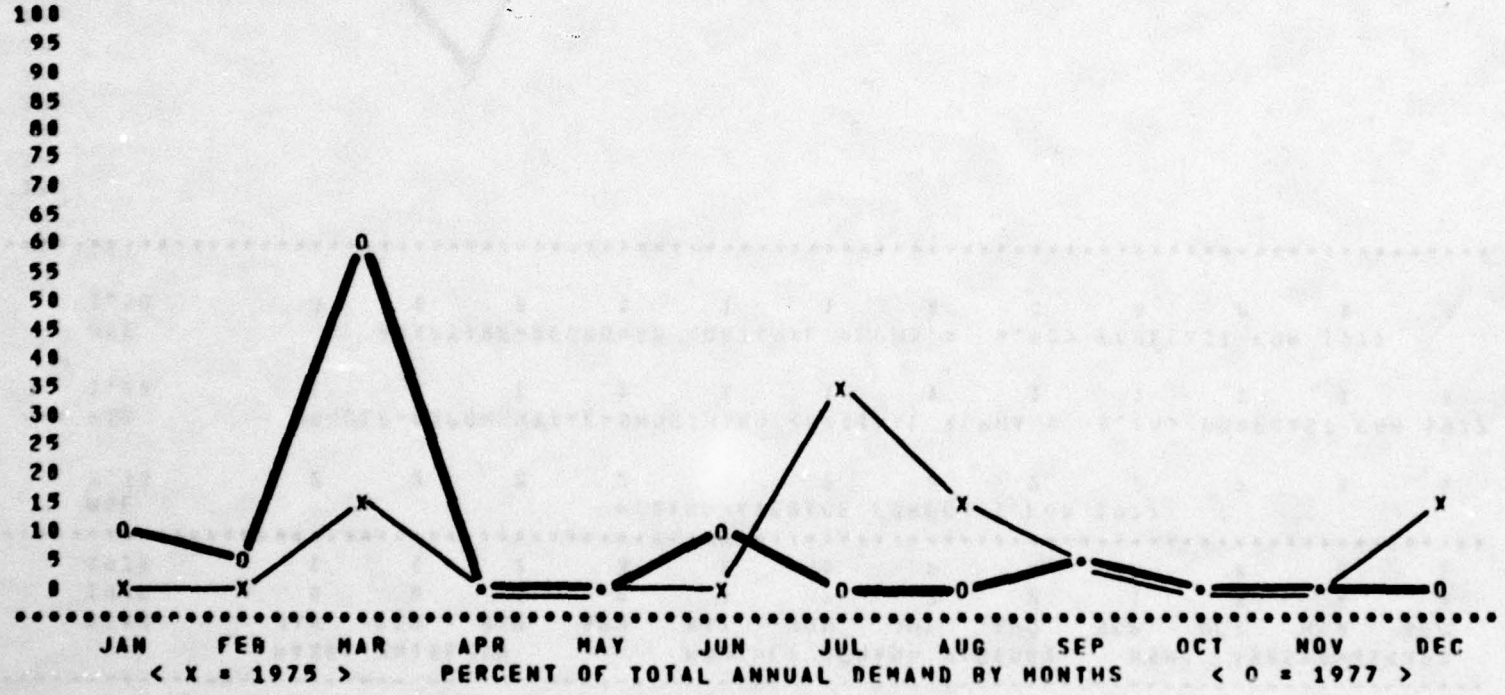
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009269197

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	6	0	0	0	12	6	2	0	0	6
1977	10	5	50	0	0	10	0	0	5	0	3	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
218.75	3	4	4	8	8	8	8	7	7	7	7	7

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
202.42	2	2	3	3	4	4	4	4	5	5	5	5

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
189.25	3	8	5	5	0	0	5	8	8	0	0	7



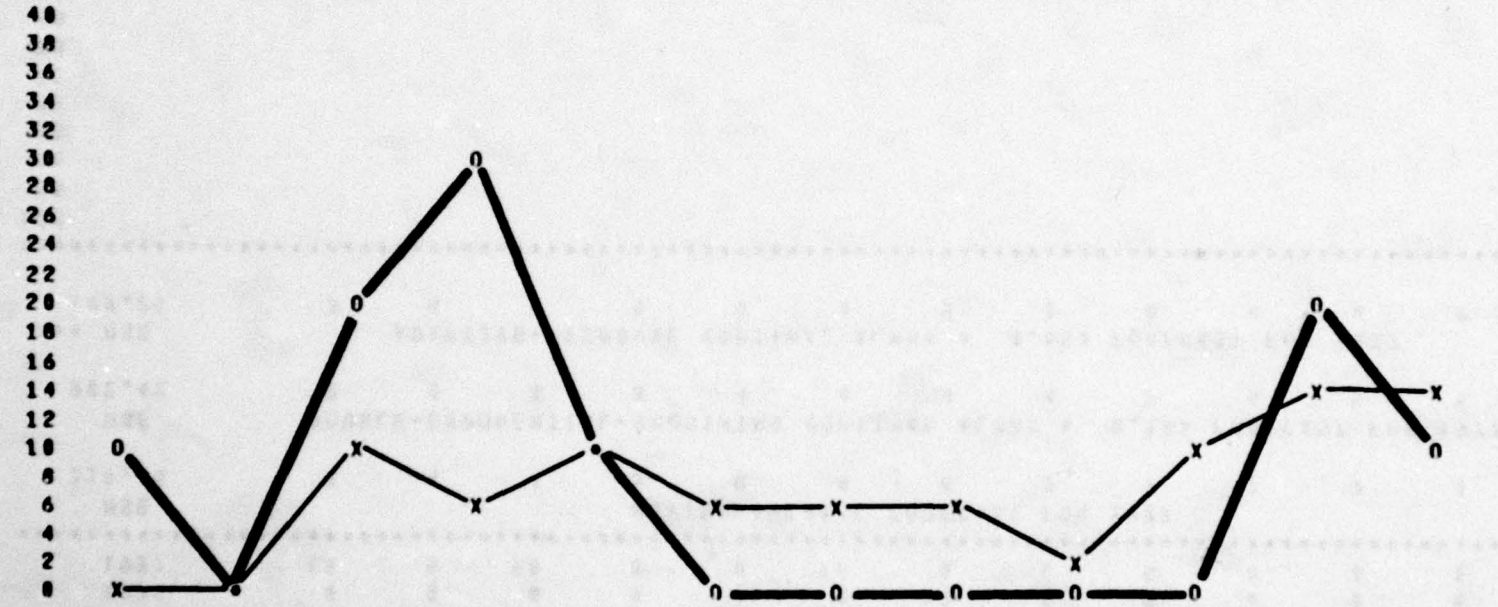
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009314329

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	3	2	3	2	2	2	1	3	4	4
1977	1	0	2	3	1	0	0	0	0	0	2	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.33	2	2	2	2	2	2	2	2	2	2	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.00	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
1.58	3	1	0	1	1	1	0	0	0	0	0	0



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009354095

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	300	790	30	30	144	360	96	120	136	96	280	336
1977	120	192	168	216	72	60	48	48	144	216	192	240

MSE					MOVING-AVERAGE FORECAST FOR 1977							
6815.67	236	214	164	175	190	184	158	154	148	149	159	151

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.70) FORECAST FOR 1977											
6313.26	273	285	192	179	196	137	94	68	56	98	168	181

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.15) FORECAST FOR 1977											
5158.58	188	318	124	149	152	176	91	73	54	48	134	203

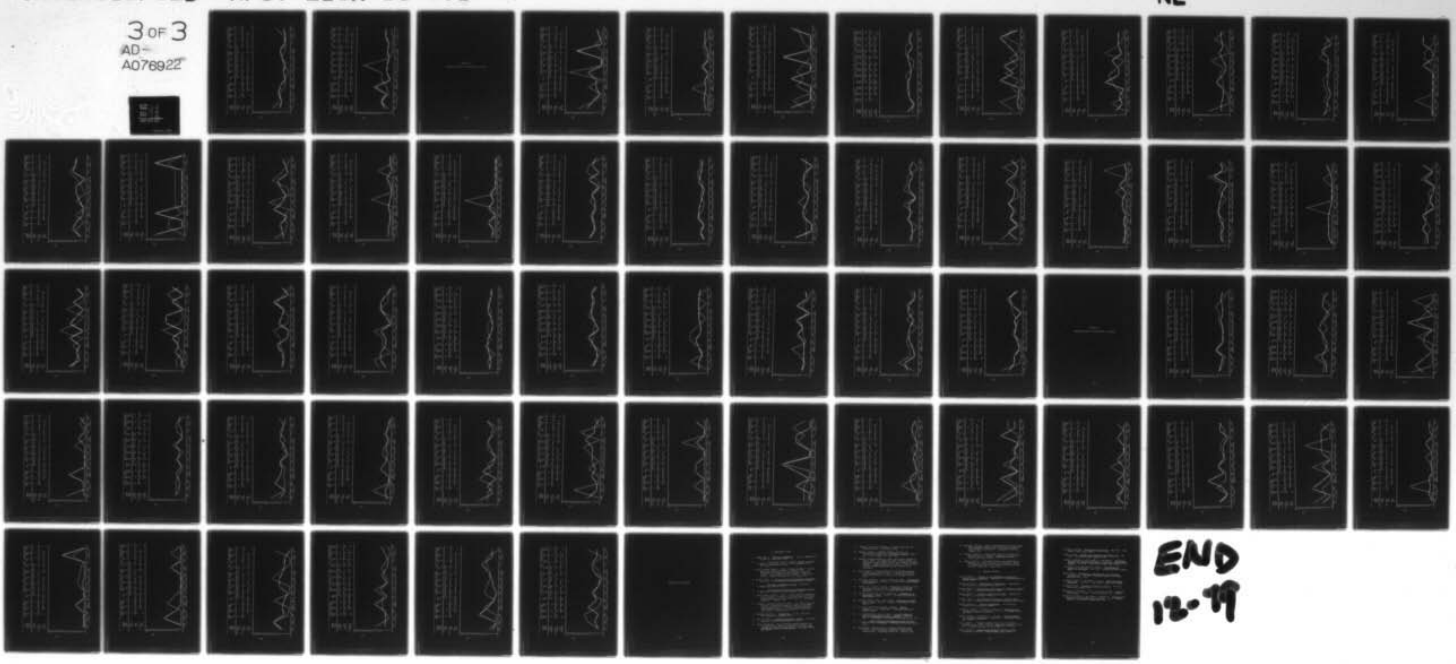
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

AD-A076 922 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5
AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MED--ETC(U)
SEP 79 V R GILLOTH , J F OHL, W A WELLS

UNCLASSIFIED AFIT-LSSR-13-79B NL

3 OF 3
AD-
A076922



END
12-79

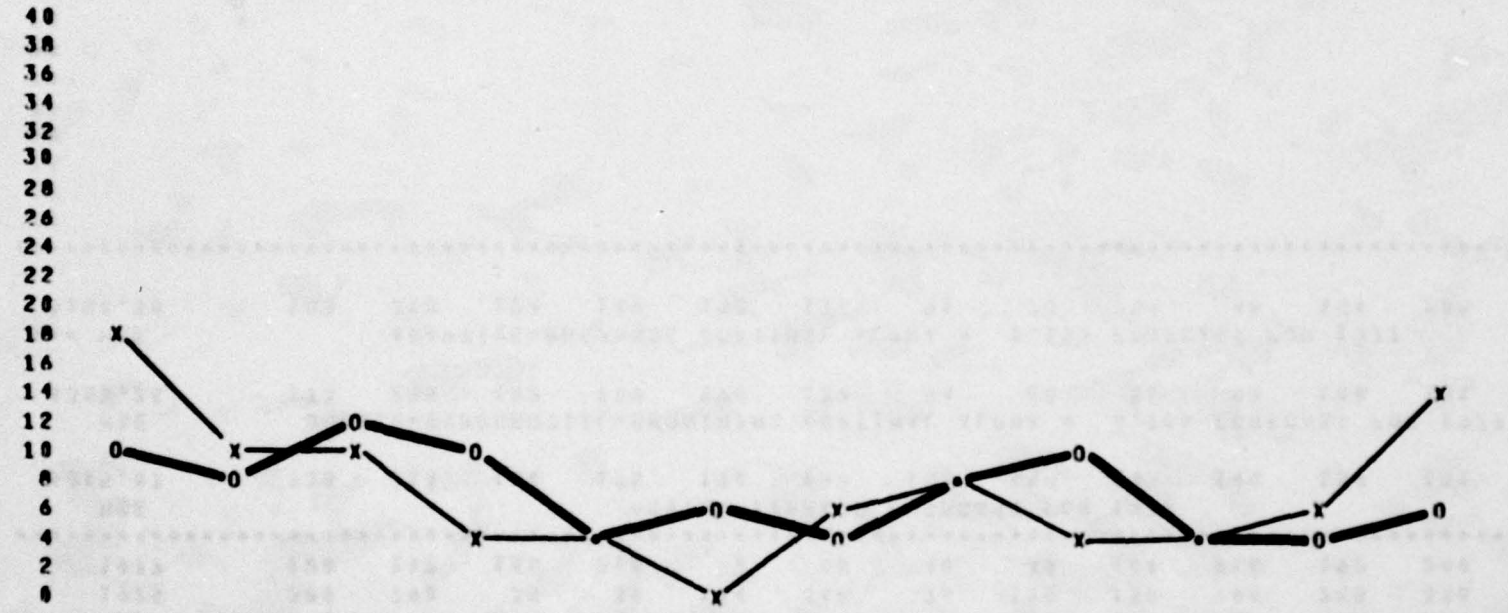
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009857301

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	24	14	13	6	7	8	8	12	5	7	8	18
1977	9	8	12	9	5	6	5	7	9	5	5	6

MSE					MOVING-AVERAGE FORECAST FOR 1977							
7.42	10	9	8	8	9	8	9	9	8	9	8	8

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
5.42	10	10	10	10	10	9	8	7	7	7	7	6

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
4.33	8	13	9	8	8	8	5	5	5	5	8	5



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

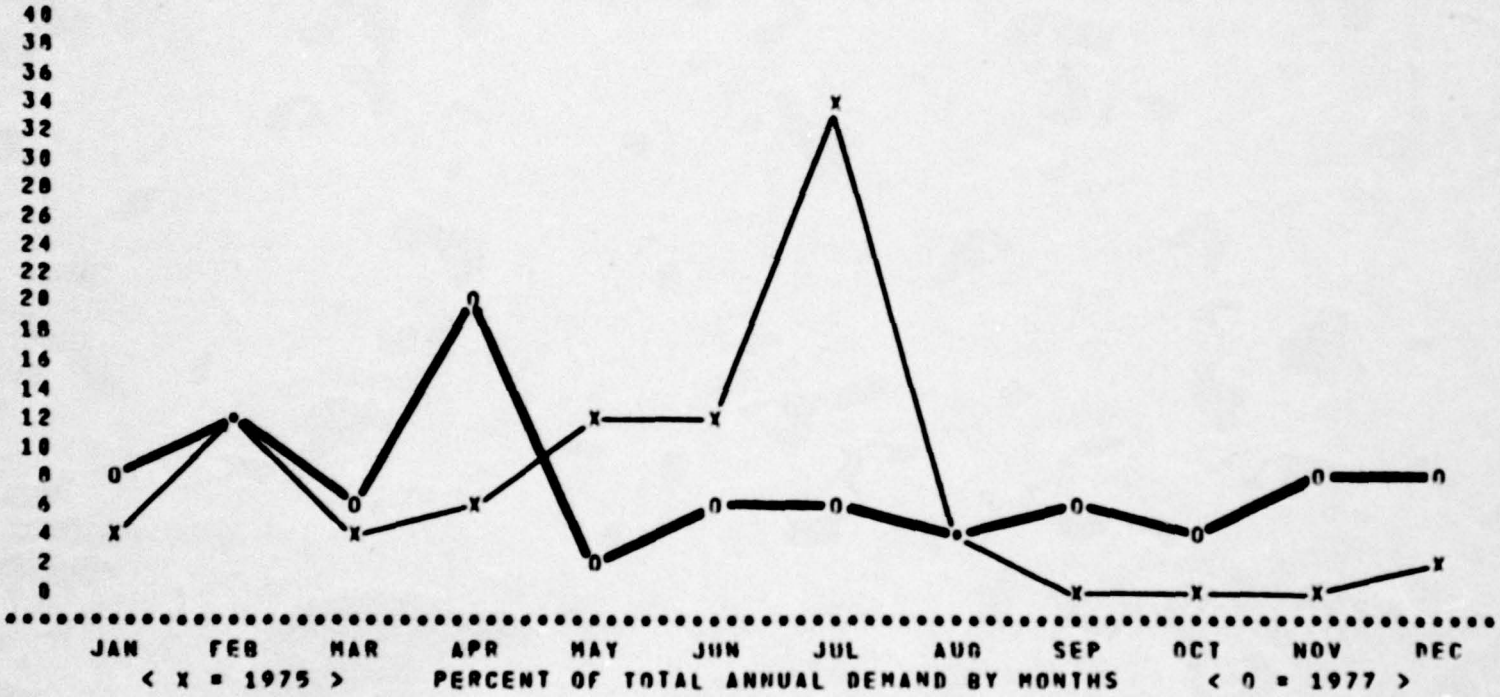
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 4505009984381

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	28	12	16	26	27	77	12	0	0	0	6
1977	19	28	14	47	6	14	16	11	14	13	20	20

MSE	MOVING-AVERAGE FORECAST FOR 1977											
100.00	18	19	19	19	21	20	19	14	13	15	16	17

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
101.67	18	18	18	18	18	18	18	18	18	18	18	18

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
153.00	8	5	16	27	14	31	10	12	12	11	11	12



APPENDIX F

COMPUTER PRODUCTS, NONSEASONAL (OFFUTT)

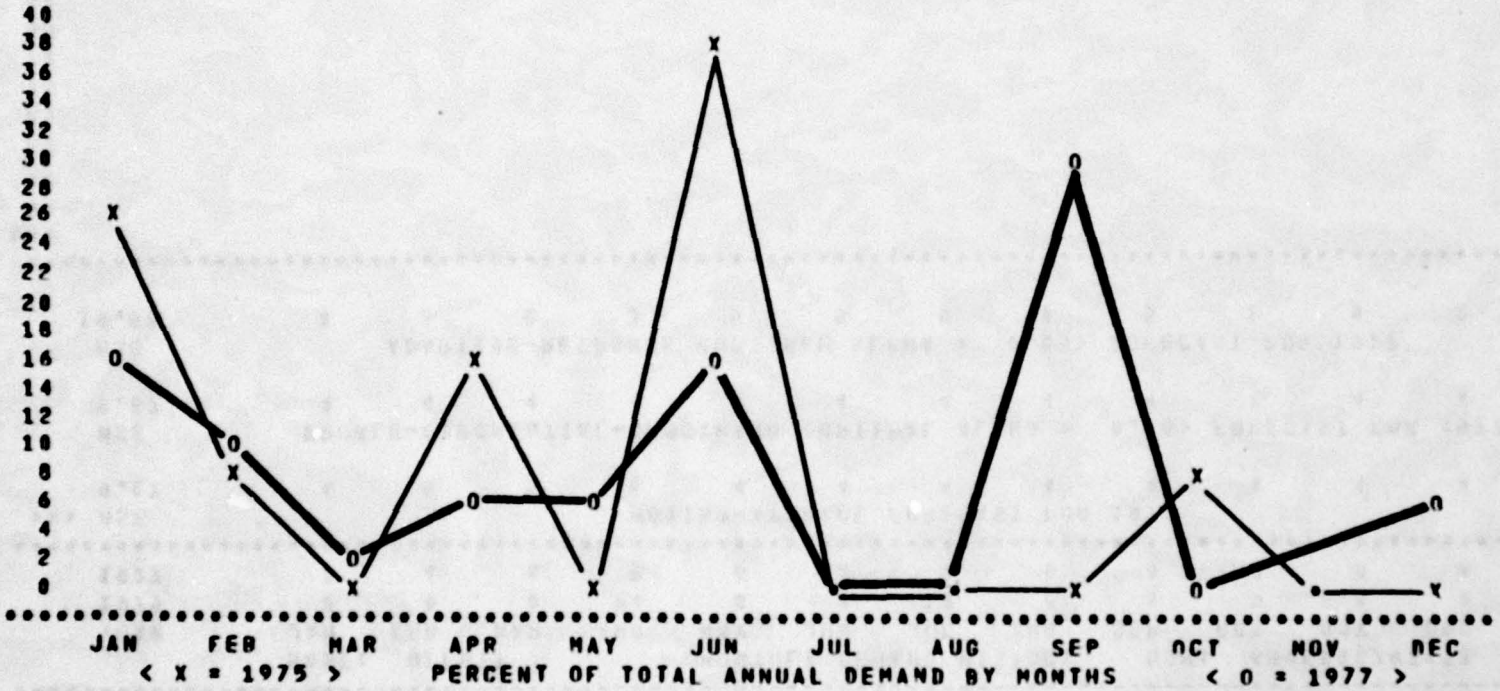
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008716547

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	2	0	4	0	9	0	0	0	2	0	0
1977	5	3	1	2	2	5	0	0	9	0	0	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
7.00	2	2	2	2	2	2	2	2	2	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
7.00	3	3	3	3	3	3	3	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
11.50	0	0	3	3	1	1	1	4	0	0	7	0



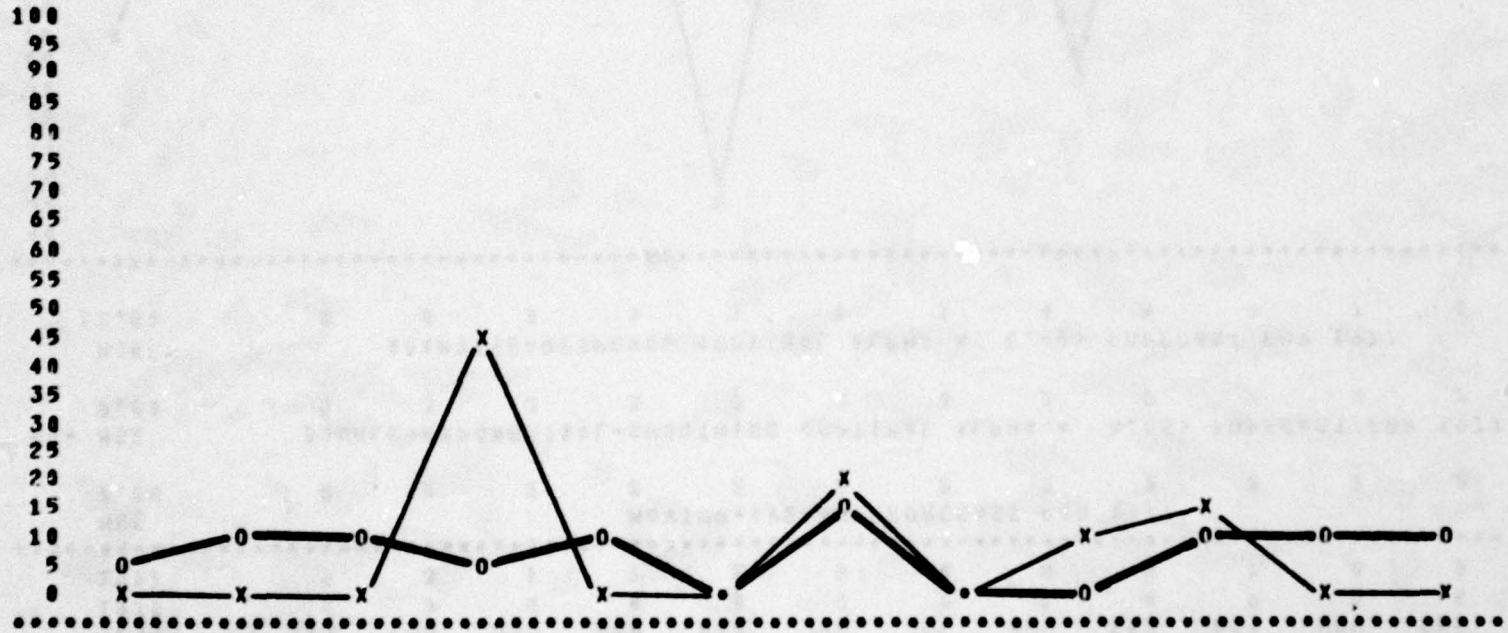
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008797453

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	24	0	0	12	0	6	9	0	0
1977	3	6	6	5	6	0	9	0	0	7	0	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
9.17	4	5	5	6	4	4	4	4	4	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
9.67	4	4	4	4	4	4	4	4	4	4	4	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
19.58	0	0	0	3	5	5	5	0	5	1	0	2



< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

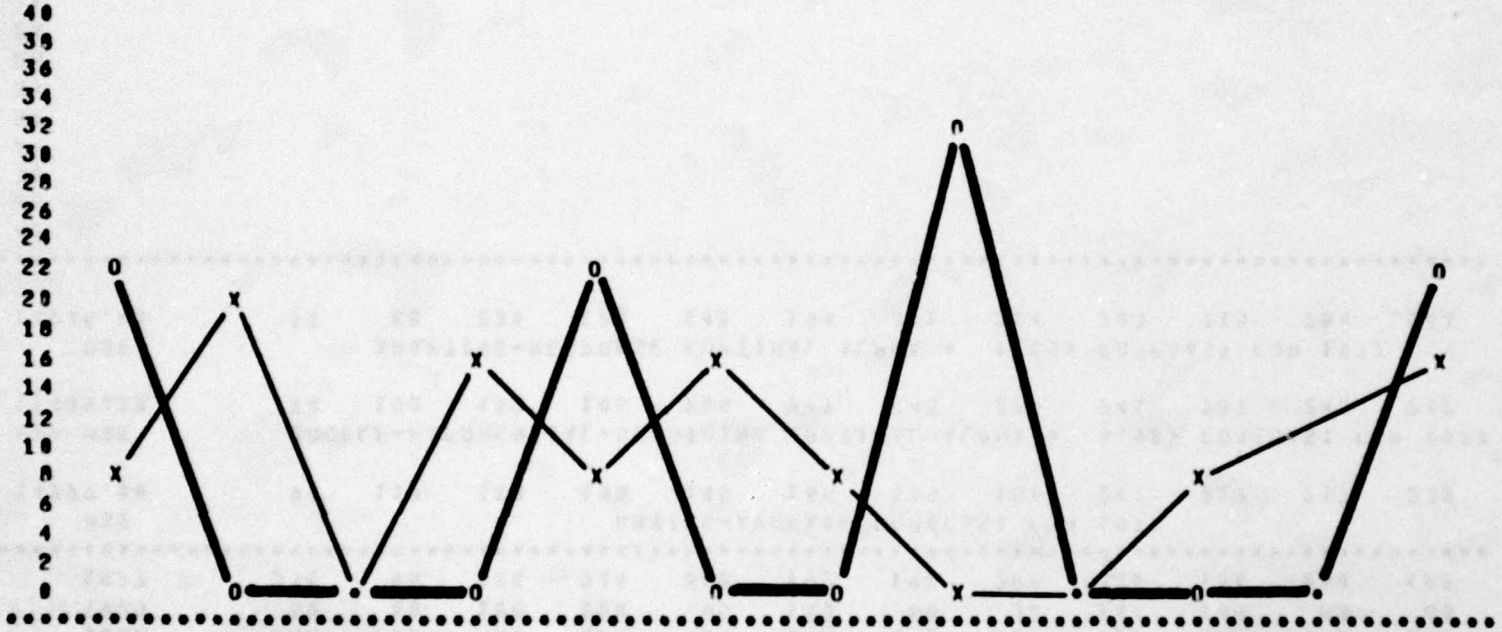
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008893424

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	5	0	4	2	4	2	0	0	2	0	4
1977	2	0	0	0	2	0	0	3	0	0	0	2

MSE				MOVING-AVERAGE FORECAST FOR 1977								
1.92	2	2	2	2	1	1	1	1	1	1	1	1

MSE				DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977								
1.67	2	2	2	1	1	1	1	1	1	1	1	1

MSE				ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977								
1.83	2	0	1	0	0	0	0	0	0	2	0	0



BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505010A7395

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	60	60	108	120	96	149	60	36	144	145	84	60
1977	336	96	288	240	342	192	192	288	336	144	264	192

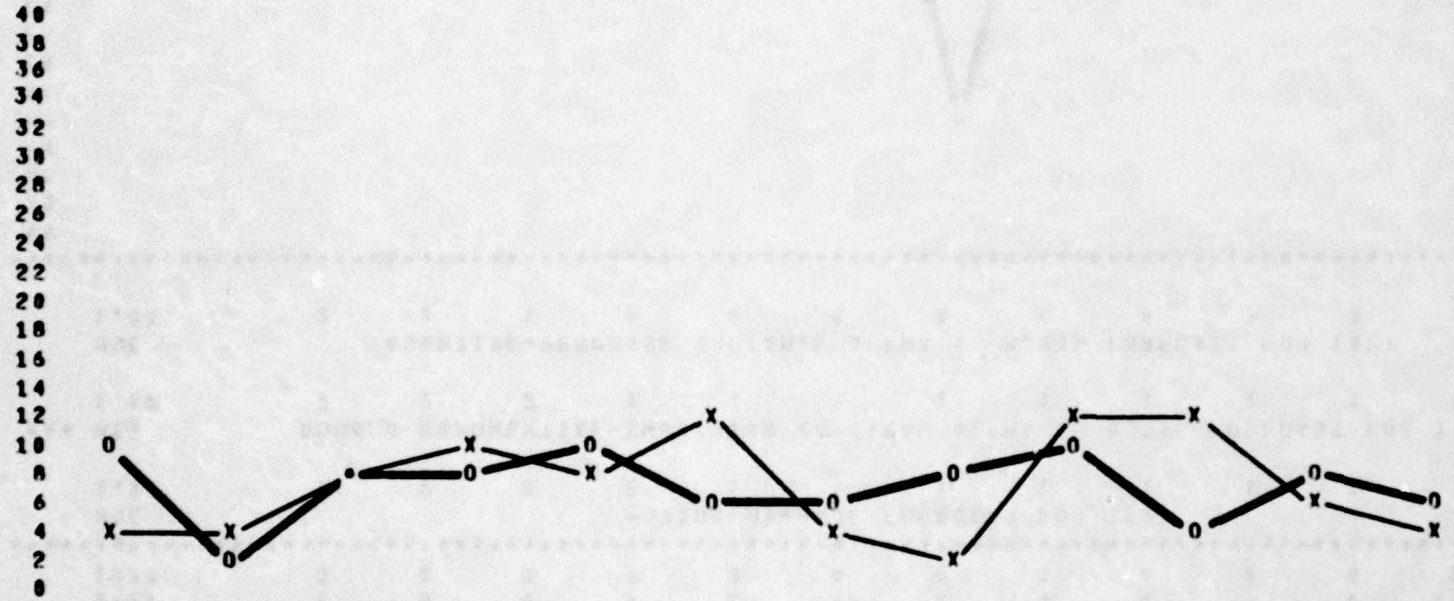
MSE					MOVING-AVERAGE FORECAST FOR 1977							
14779.00	94	117	128	135	145	165	169	180	201	217	217	232

MSE												
11439.17	94	152	152	186	208	247	243	229	241	267	243	242

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977

MSE												
13946.00	75	88	236	122	145	194	301	204	203	215	284	163

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977



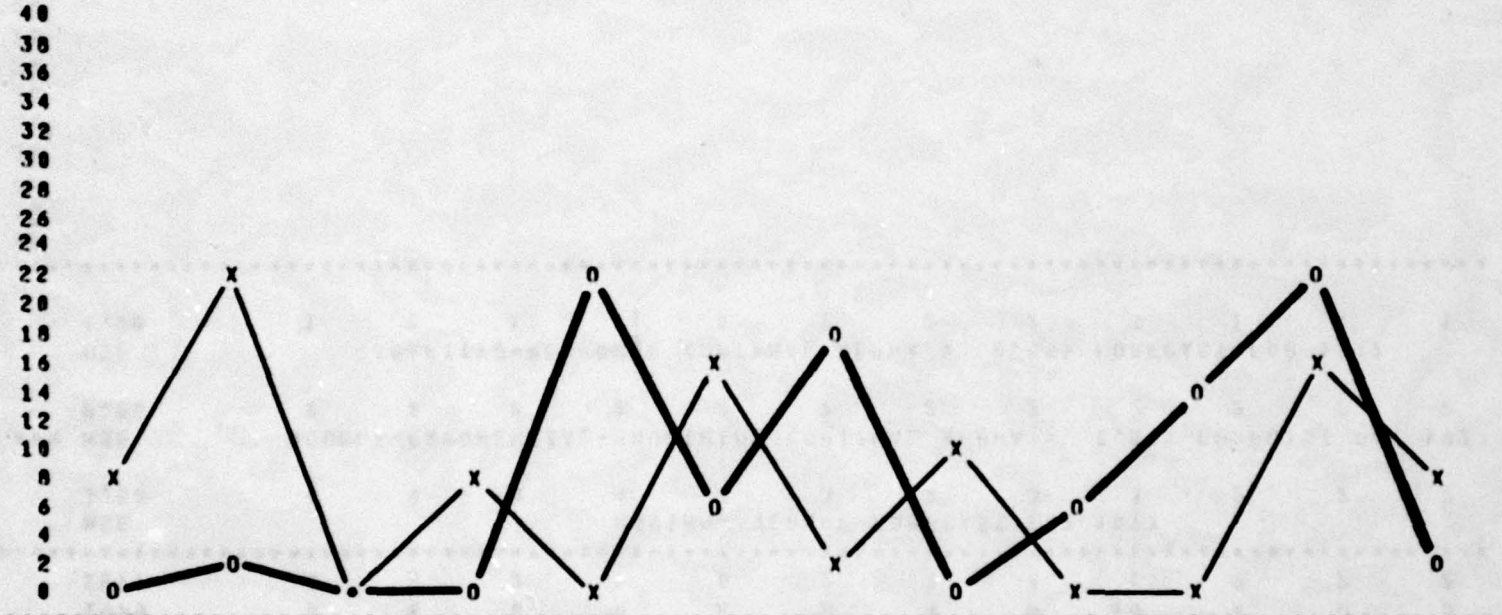
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001153285

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	16	0	6	0	11	2	8	0	0	12	6
1977	0	1	0	0	6	2	5	0	2	4	6	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
10.42	6	5	4	4	3	4	3	3	3	3	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
8.92	5	5	4	3	3	3	3	3	3	2	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
8.42	4	5	0	0	0	0	1	1	4	0	0	1



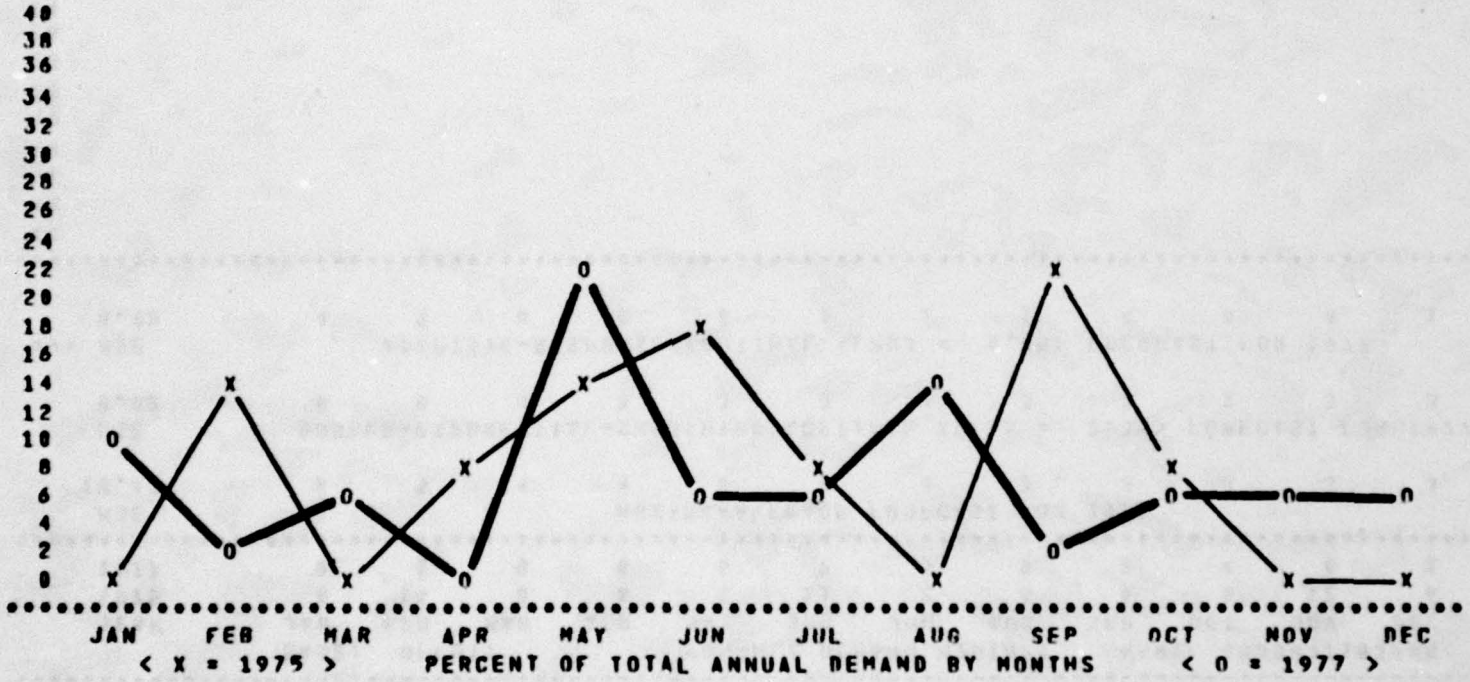
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001169660

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	0	4	6	8	4	0	10	4	0	0
1977	3	1	2	0	6	2	2	4	1	2	2	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3.58	4	4	3	4	3	3	3	3	3	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
2.25	2	2	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977											
4.50	1	2	1	1	0	2	2	2	3	1	1	1



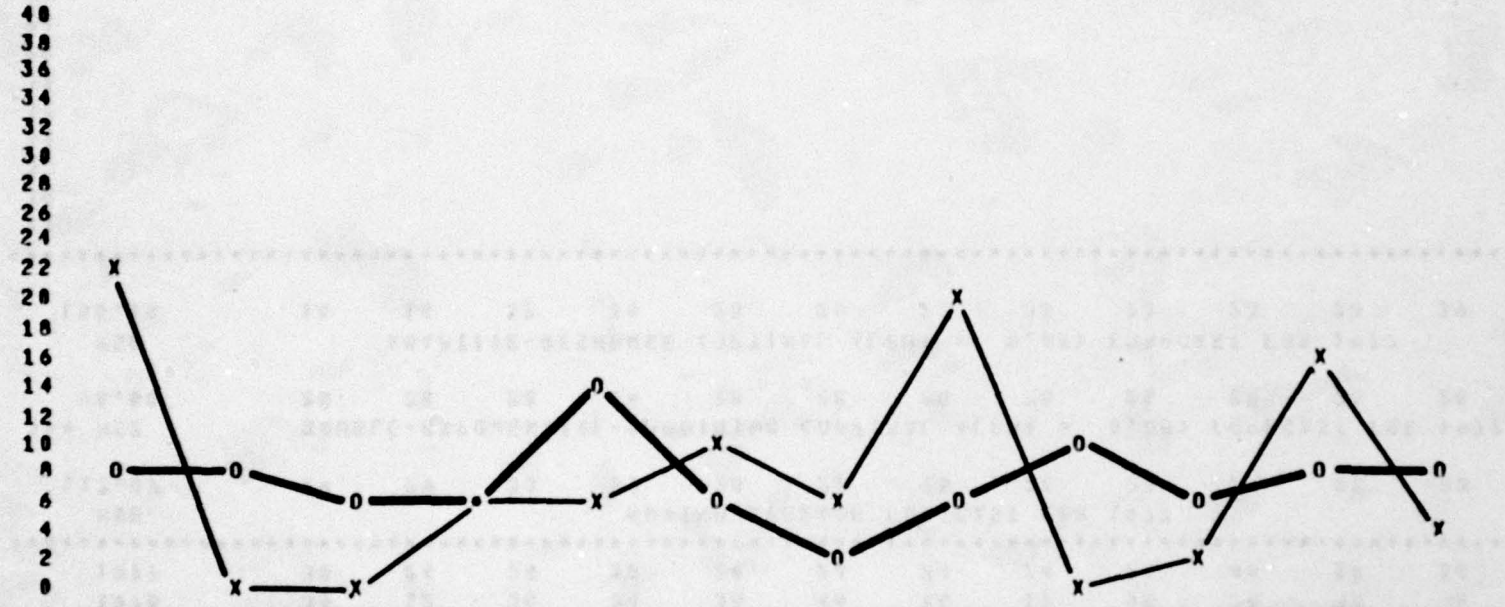
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505801199321

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	9	0	0	3	3	4	3	8	0	1	7	2
1977	21	17	13	15	32	16	8	16	23	14	19	17

MSE	MOVING-AVERAGE FORECAST FOR 1977											
115.88	3	4	6	7	8	10	11	12	12	14	15	16

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
76.63	3	11	14	14	15	22	20	15	15	18	17	18

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
79.88	1	19	17	15	15	24	16	13	15	16	14	14



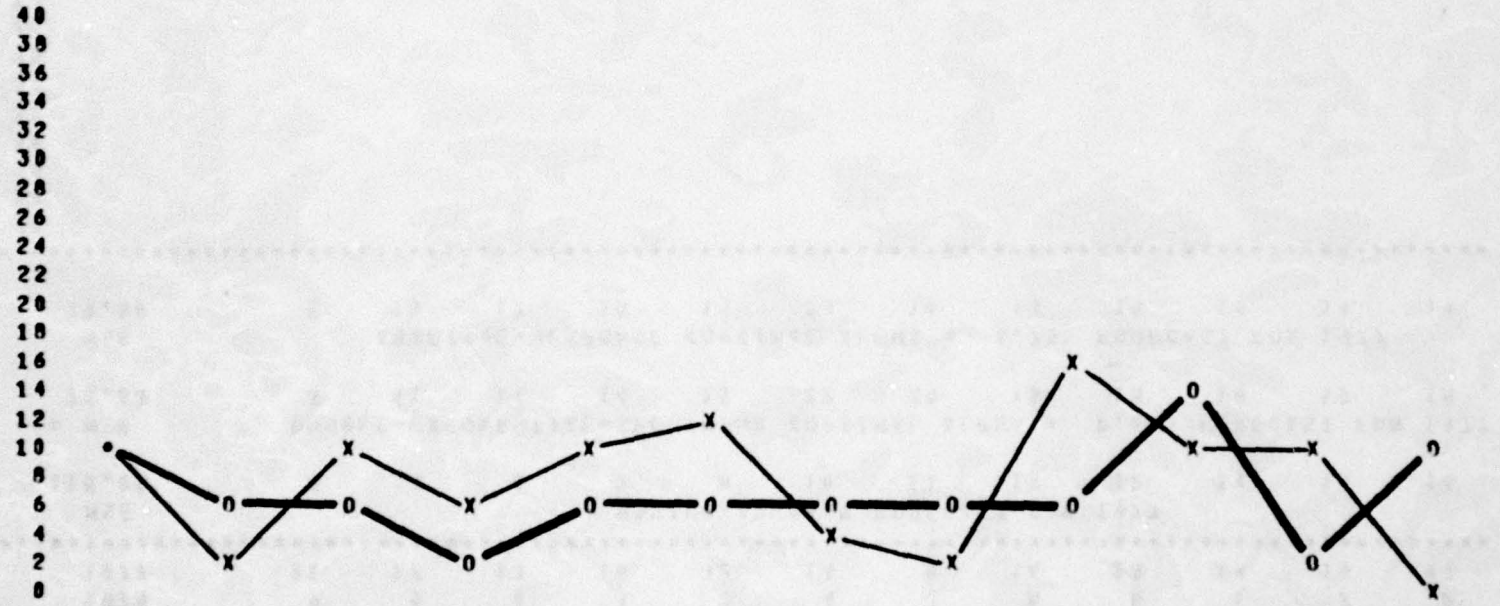
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001387488

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	36	12	36	24	36	44	16	12	58	36	36	8
1977	36	24	24	12	24	24	24	24	24	48	12	36

MSE	MOVING-AVERAGE FORECAST FOR 1977											
112.67	29	29	30	29	28	27	25	26	27	24	25	23

*** MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
96.00	28	28	28	28	28	28	28	28	28	28	28	28

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
155.00	16	16	32	30	28	20	23	23	23	23	23	39



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

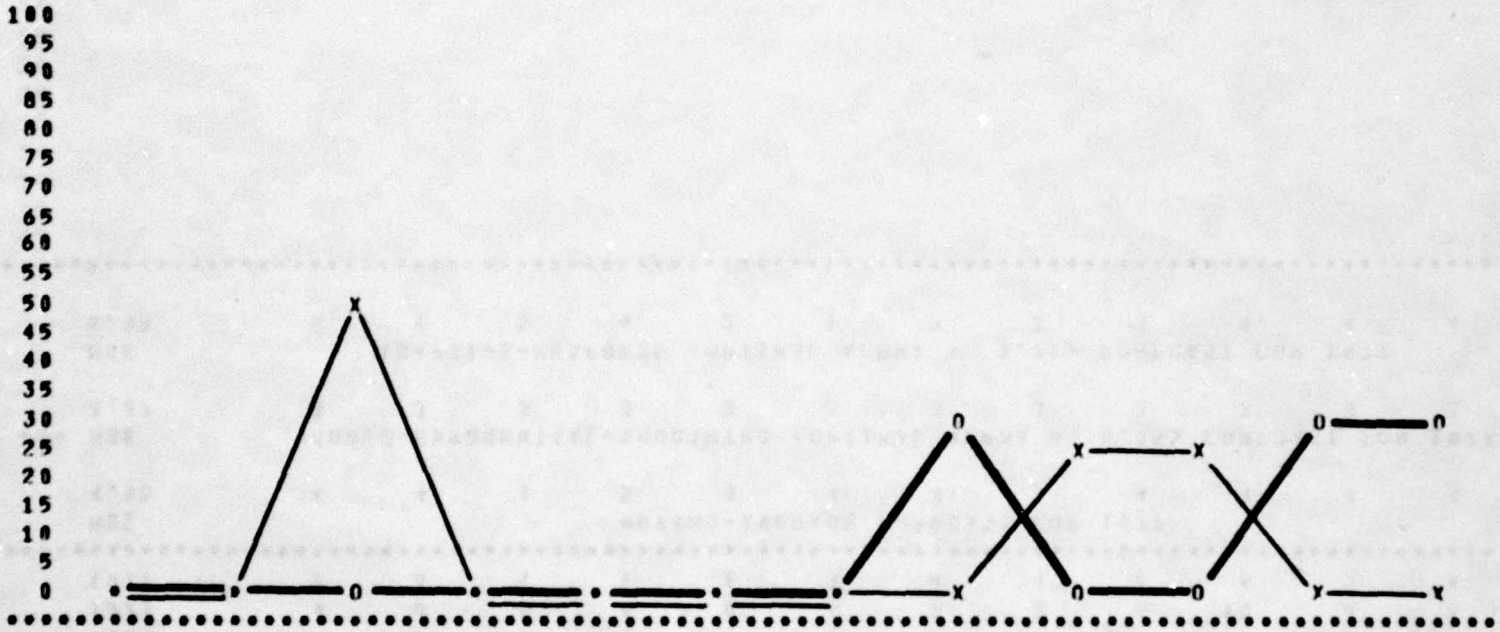
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001490107

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	2	0	0	0	0	0	1	1	0	0
1977	0	0	0	0	0	0	0	1	0	0	1	1

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.25	0	0	0	0	0	0	0	0	0	0	0	0

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
0.18	0	0	0	0	0	0	0	0	0	0	0	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977											
0.17	0	0	0	0	0	0	0	0	0	0	0	1



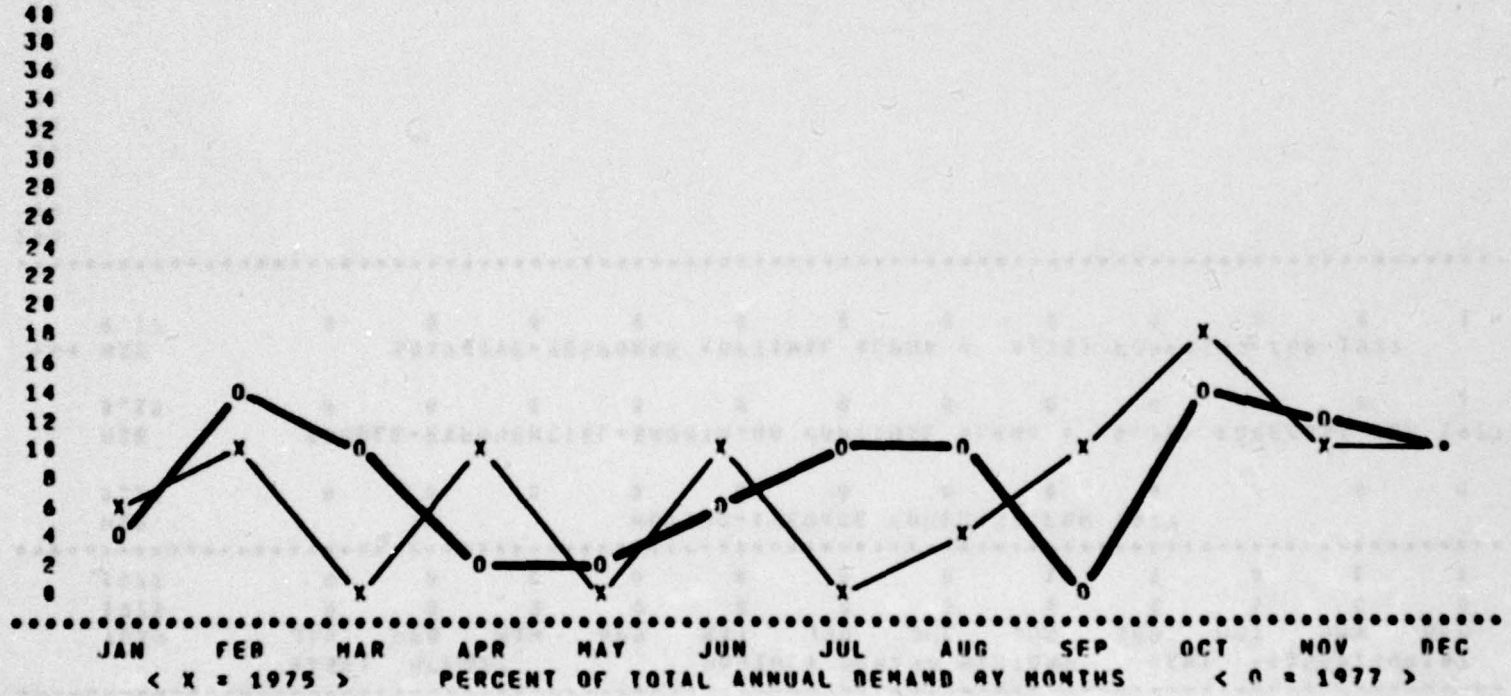
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505801534199

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	6	8	6	8	6	8	3	6	10	6	6
1977	2	6	4	1	1	3	4	4	8	6	5	4

MSE	MOVING-AVERAGE FORECAST FOR 1977											
4.58	4	4	4	5	4	4	4	4	4	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
3.67	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
6.58	5	4	5	4	2	1	2	3	3	0	4	4



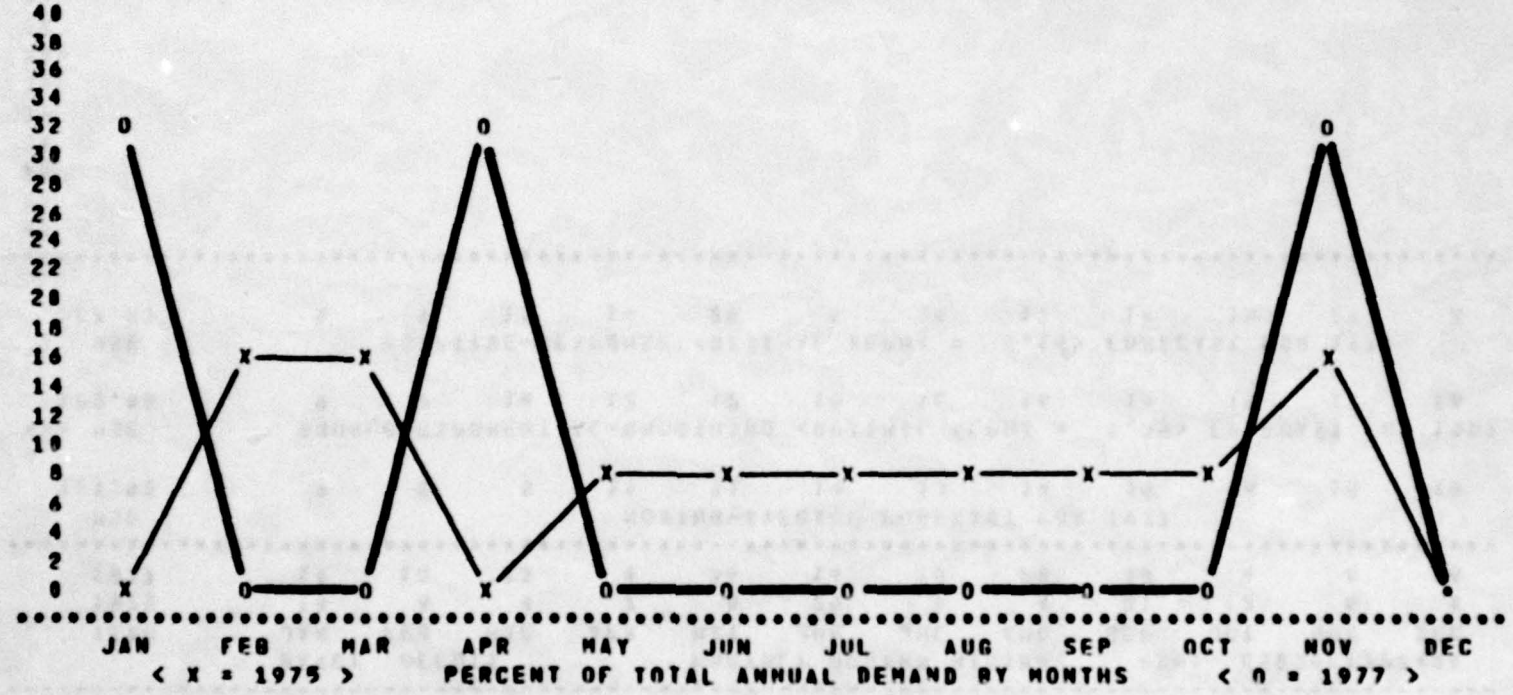
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505081594893

YEAR	JAN	FEB	MAR	APP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	2	2	0	1	1	1	1	1	1	2	0
1977	1	0	0	1	0	0	0	0	0	0	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.67	1	1	1	1	1	1	1	1	1	0	0	0

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.45) FORECAST FOR 1977											
0.33	1	1	1	1	1	0	0	0	0	0	0	0

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
0.25	0	0	0	0	0	0	0	0	0	0	0	0



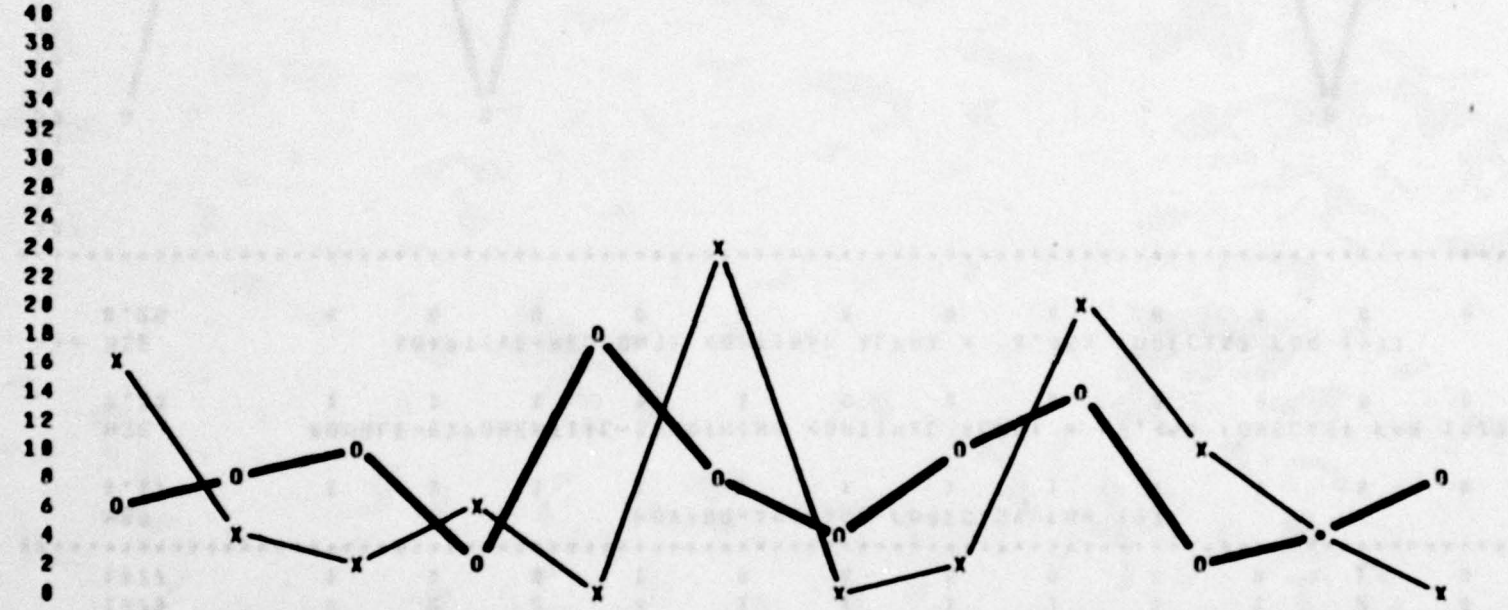
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505001723420

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	18	6	4	7	0	25	0	4	21	12	6	0
1977	14	18	23	4	36	14	10	20	30	4	8	14

MSE	MOVING-AVERAGE FORECAST FOR 1977											
121.92	9	8	9	11	11	14	13	14	15	14	15	15

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.35) FORECAST FOR 1977											
120.88	9	9	10	12	12	15	16	16	14	10	17	16

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.10) FORECAST FOR 1977											
167.83	5	5	11	14	20	5	20	17	14	15	20	6



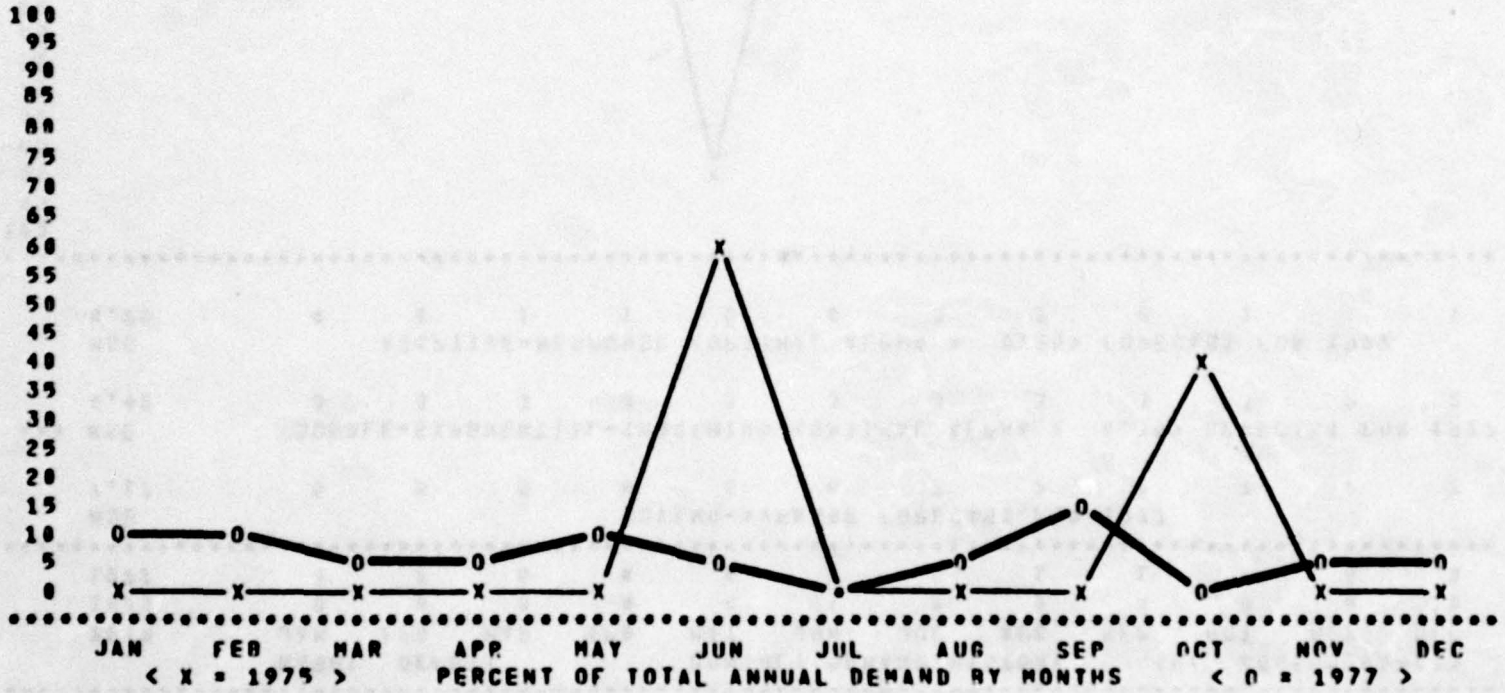
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505002001641

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	12	0	0	0	0	0	0
1977	8	10	7	4	8	5	0	4	12	0	6	7

MSE	MOVING-AVERAGE FORECAST FOR 1977											
19.83	2	2	3	4	4	5	4	4	5	6	5	5

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
18.33	2	3	4	5	5	5	6	5	5	5	5	5

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
28.88	0	0	0	0	7	5	5	5	2	3	3	0



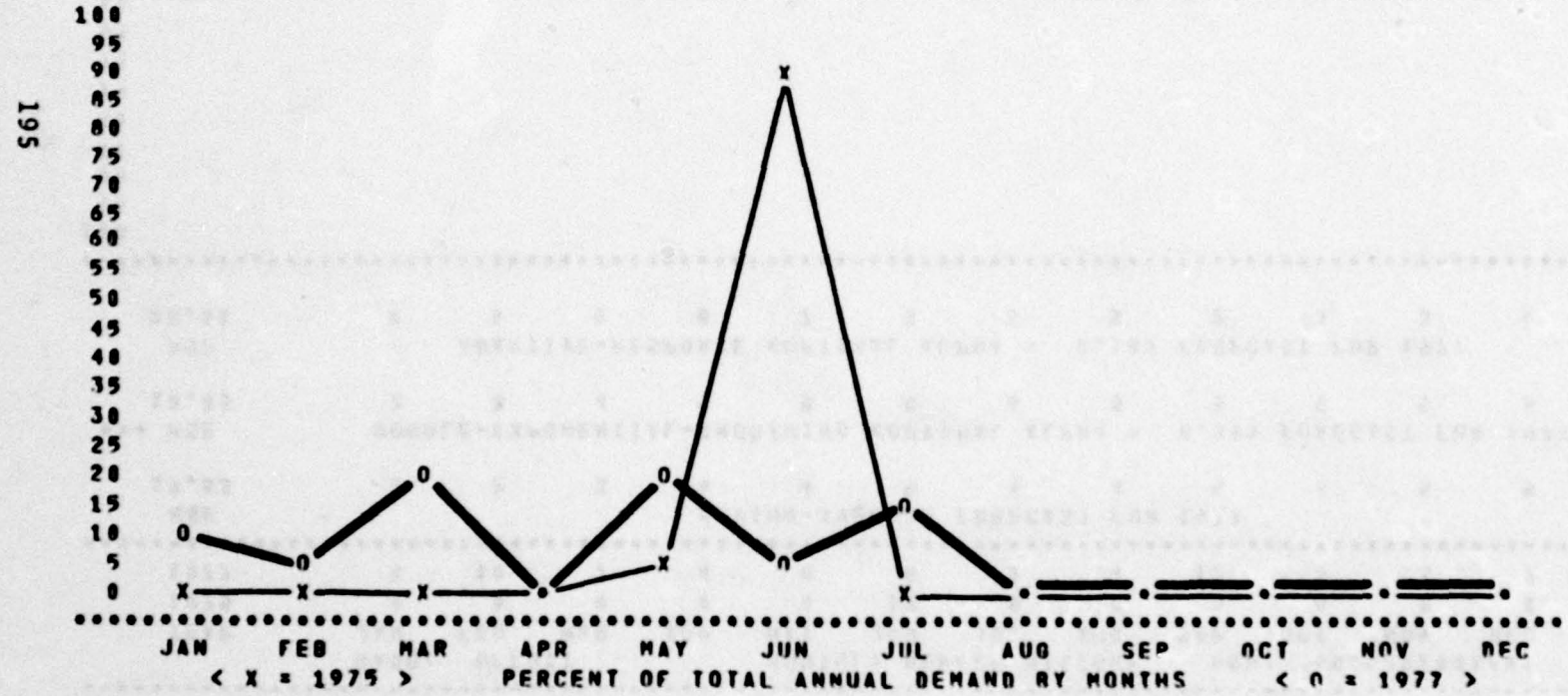
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505002904433

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	4	51	0	0	0	0	0	0
1977	3	2	6	0	6	2	5	1	1	1	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
7.17	5	5	5	6	6	6	2	2	2	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.35) FORECAST FOR 1977											
4.42	3	3	3	3	3	3	3	3	3	3	2	2

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.25) FORECAST FOR 1977											
8.25	0	0	1	1	5	0	3	2	2	1	1	1



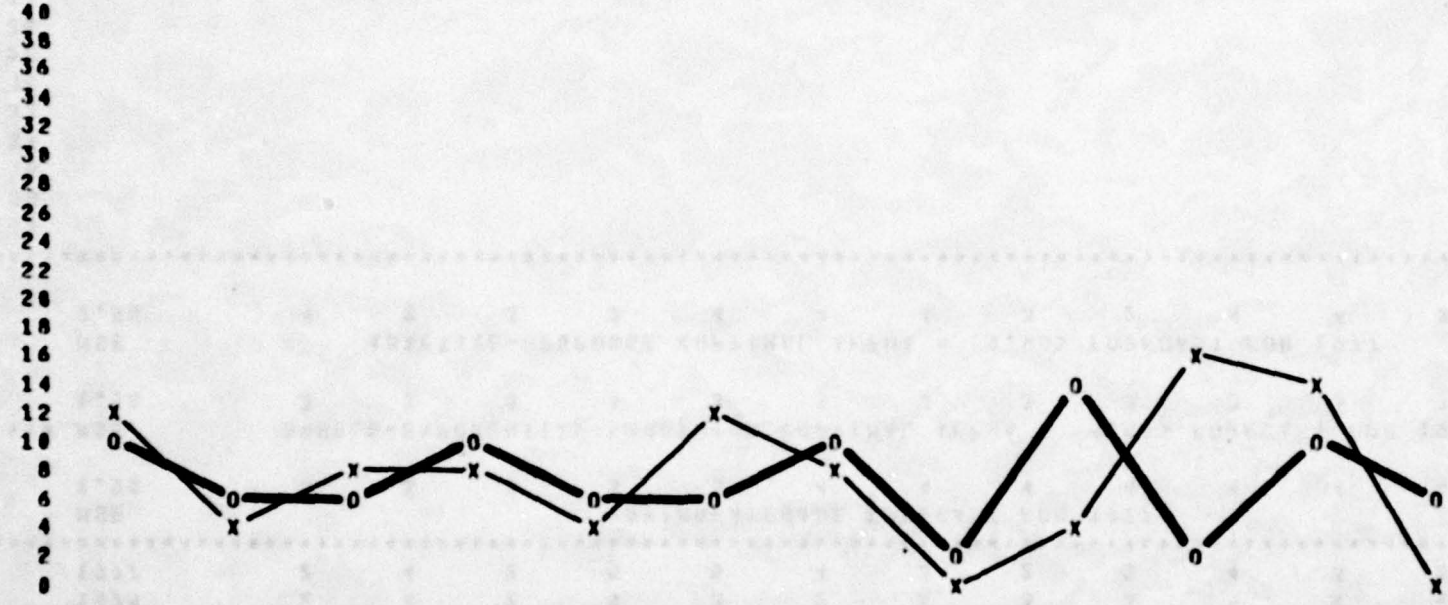
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 4505004007294

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	2	4	4	2	6	4	8	2	8	7	8
1977	3	2	2	3	2	2	3	1	4	1	3	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.67	4	4	4	3	3	3	3	3	3	3	3	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
1.25	4	3	3	3	3	2	2	2	2	3	2	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
2.25	8	2	2	2	2	2	2	2	1	2	1	1



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

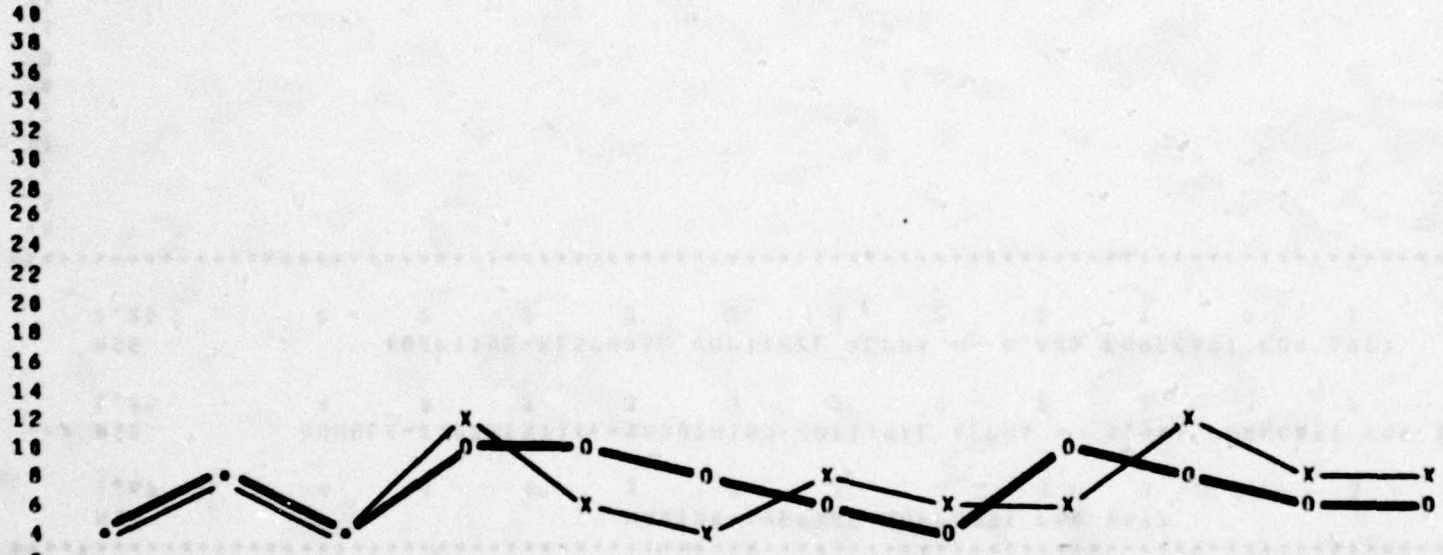
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005508464

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	4	2	5	3	2	4	3	3	5	4	4
1977	2	4	2	5	5	4	3	2	5	4	3	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.58	3	3	3	3	3	4	4	4	4	4	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.58	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977											
2.58	4	2	3	2	4	4	4	3	2	4	4	3



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

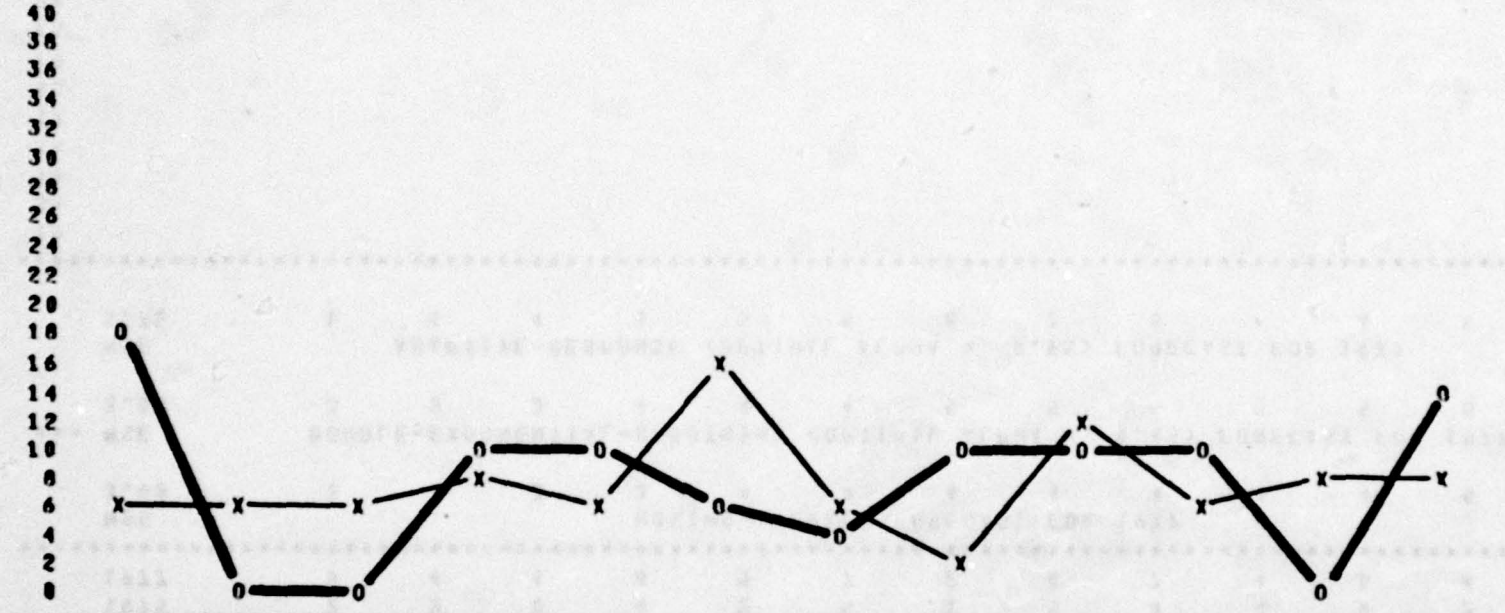
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005824679

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	12	12	18	12	30	12	6	26	12	16	18
1977	11	0	0	6	6	4	3	7	6	7	0	9

MSE	MOVING-AVERAGE FORECAST FOR 1977											
59.58	16	15	14	13	12	12	10	9	9	7	7	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
31.80	17	13	5	1	4	5	5	4	6	6	7	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
24.17	16	14	11	6	8	5	5	4	3	5	5	6



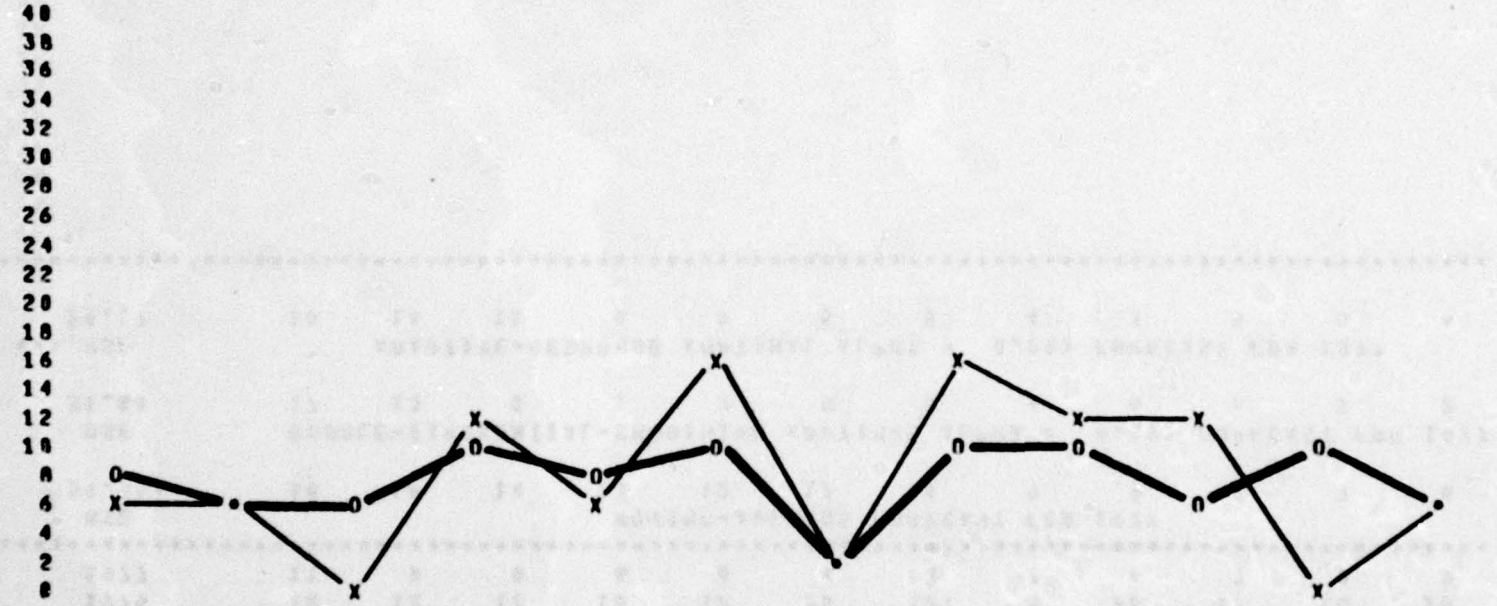
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505005842A95

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	2	0	4	2	5	1	5	4	4	0	2
1977	5	4	4	6	5	7	2	6	7	4	6	4

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3.92	3	3	3	3	4	4	4	4	4	4	4	5

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
3.88	3	3	3	4	4	4	5	5	5	5	5	5

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
5.75	1	4	4	4	5	5	6	2	5	4	4	5



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

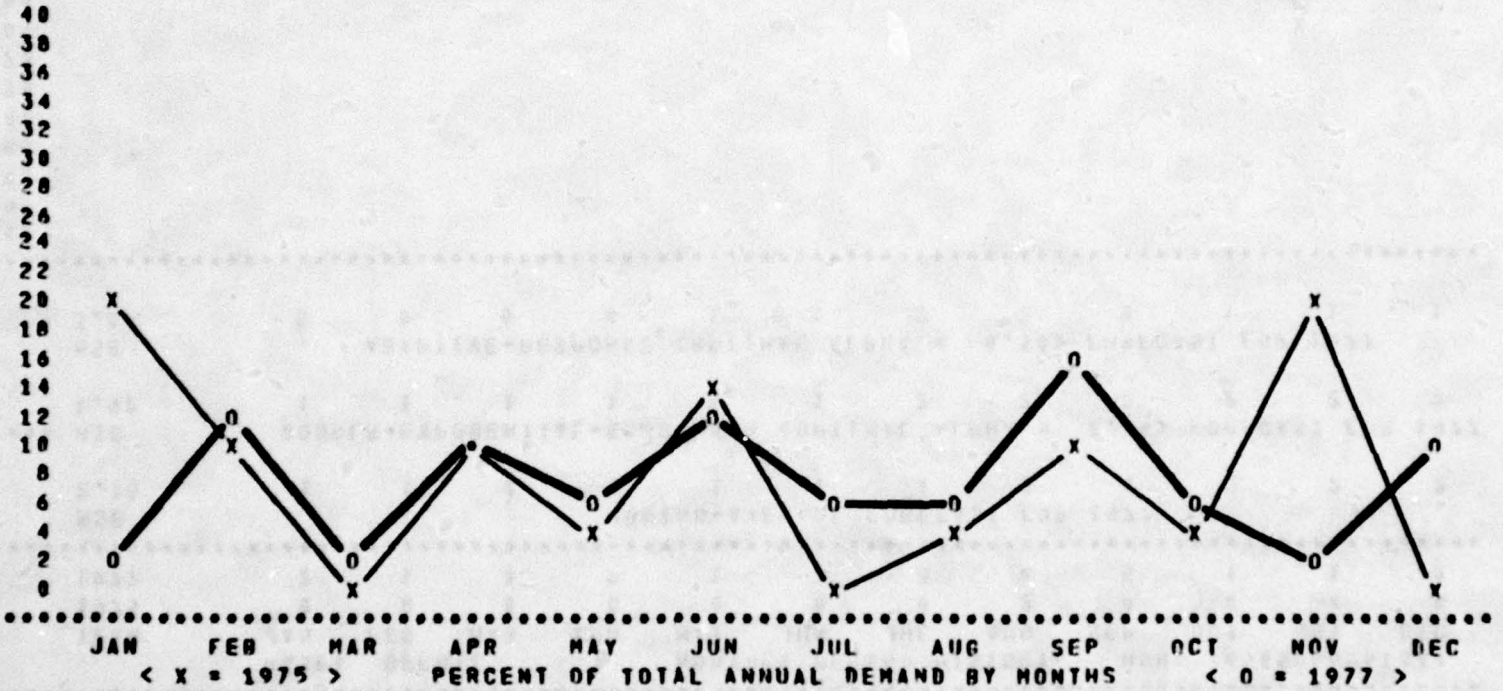
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006167836

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	2	0	2	1	3	0	1	2	1	4	0
1977	1	4	1	3	2	4	2	2	5	?	1	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.50	2	1	2	?	2	2	2	2	?	?	3	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
1.83	2	2	2	2	2	2	2	2	?	?	2	?

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.75) FORECAST FOR 1977											
3.33	0	0	1	1	2	2	3	2	2	?	2	1



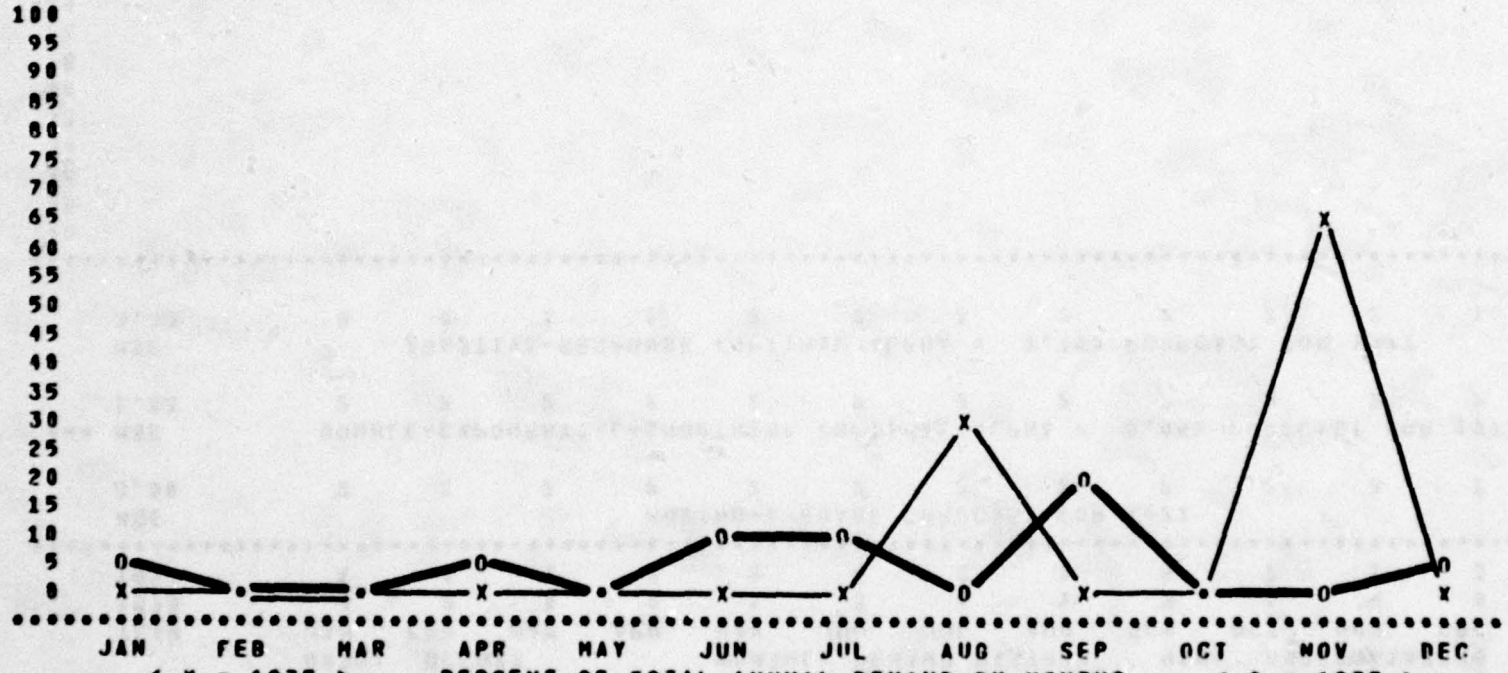
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505806561344

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	0	0	2	0	0	4	0
1977	2	1	0	2	1	3	3	0	5	1	1	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.75	1	1	1	1	1	1	1	2	1	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.45) FORECAST FOR 1977											
1.92	1	1	1	1	1	1	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.50) FORECAST FOR 1977											
3.67	0	0	0	0	1	1	2	2	0	1	1	1



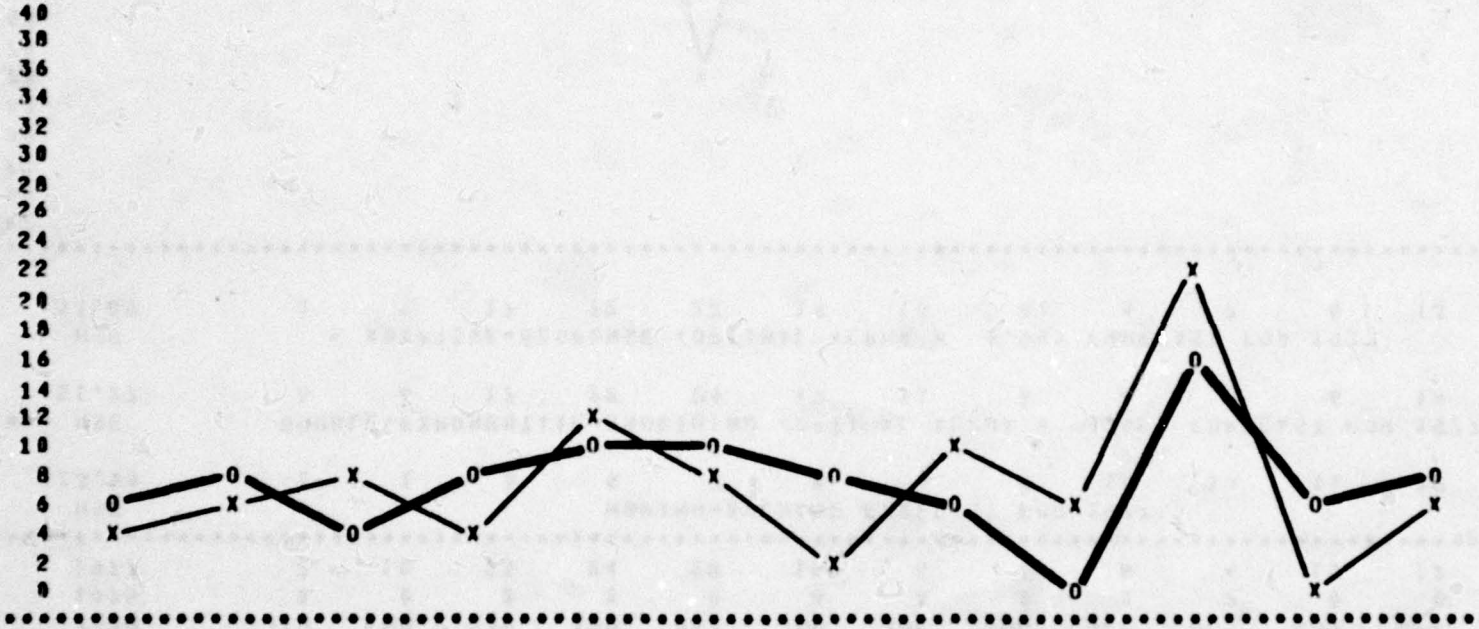
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505006648857

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	6	7	4	12	8	3	10	6	20	8	6
1977	4	6	3	6	7	7	5	4	0	11	4	5

MSE	MOVING-AVERAGE FORECAST FOR 1977											
8.50	7	7	7	7	7	7	7	7	6	6	5	5

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
7.17	6	6	6	6	6	6	6	6	6	6	6	6

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
10.83	3	8	1	4	3	4	6	6	5	4	1	10



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

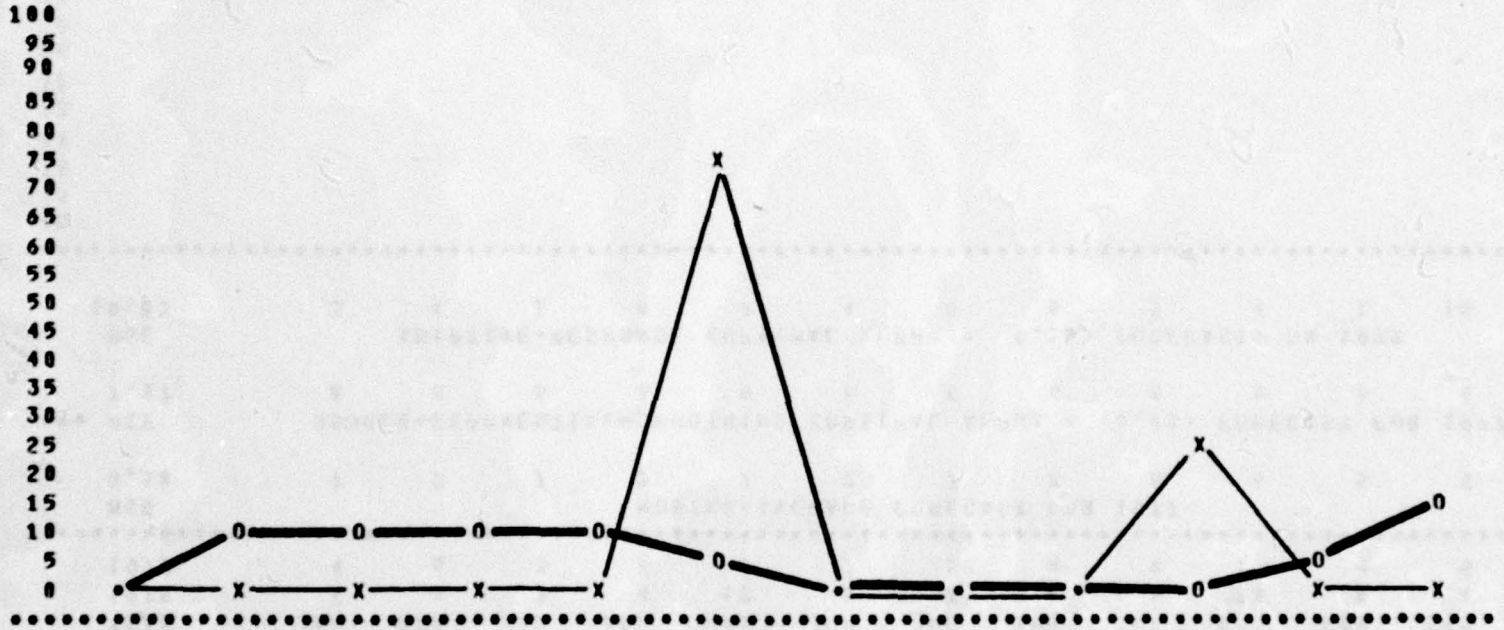
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007218899

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	6	0	0	0	2	0	0
1977	7	18	23	24	18	10	6	6	8	6	15	27

MSE	MOVING-AVERAGE FORECAST FOR 1977											
123.50	1	1	3	5	7	8	9	9	10	10	11	12

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
51.77	0	6	17	22	24	19	11	8	6	8	6	14

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
53.88	0	5	17	22	23	18	10	8	6	7	6	13



BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007542547

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	26	24	12	24	24	24	12	18	0	36	10	0
1977	12	12	19	15	19	0	10	4	0	18	4	19

MSE	MOVING-AVERAGE FORECAST FOR 1977											
58.83	18	16	15	16	15	15	13	13	11	11	10	9

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
58.25	14	12	12	13	14	15	12	11	9	7	8	8

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
58.67	12	10	11	11	13	14	17	1	7	6	4	13

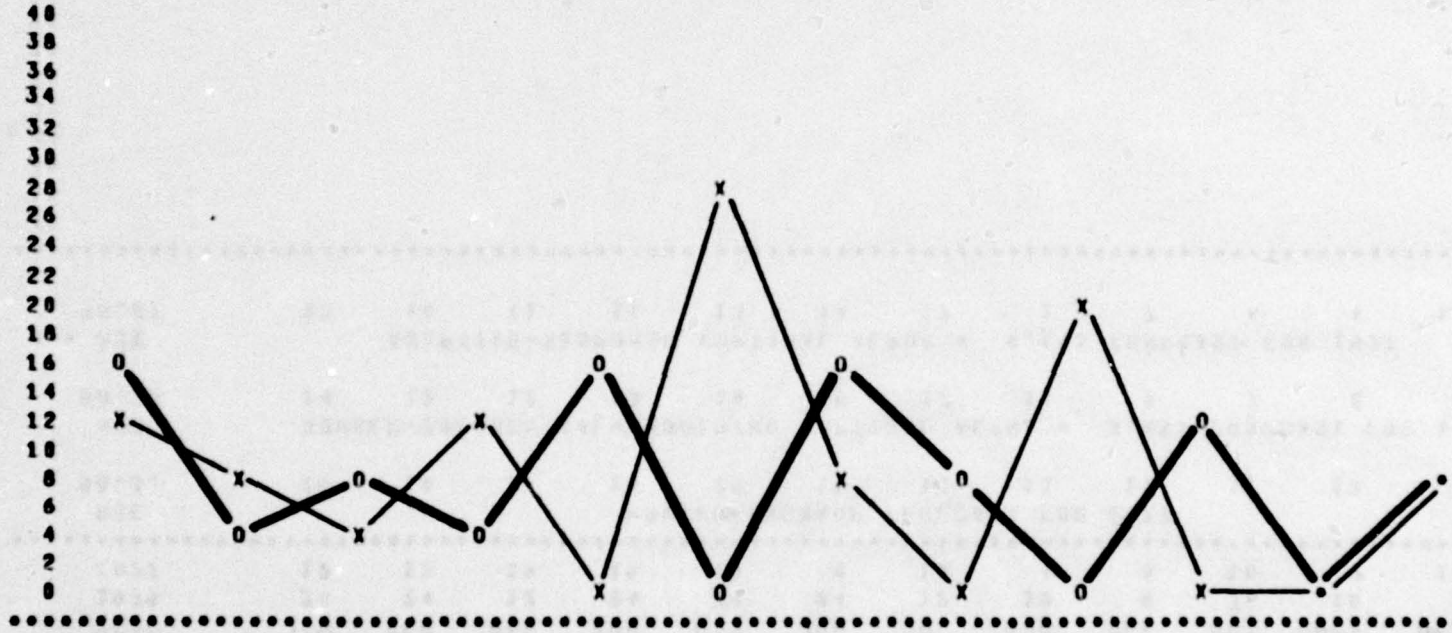
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505007650589

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	2	1	3	0	7	2	0	5	0	0	2
1977	4	1	2	1	4	0	4	2	0	3	0	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.25	2	2	2	2	2	2	2	2	2	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
2.25	2	2	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
4.67	1	1	3	1	1	1	2	0	0	1	0	0



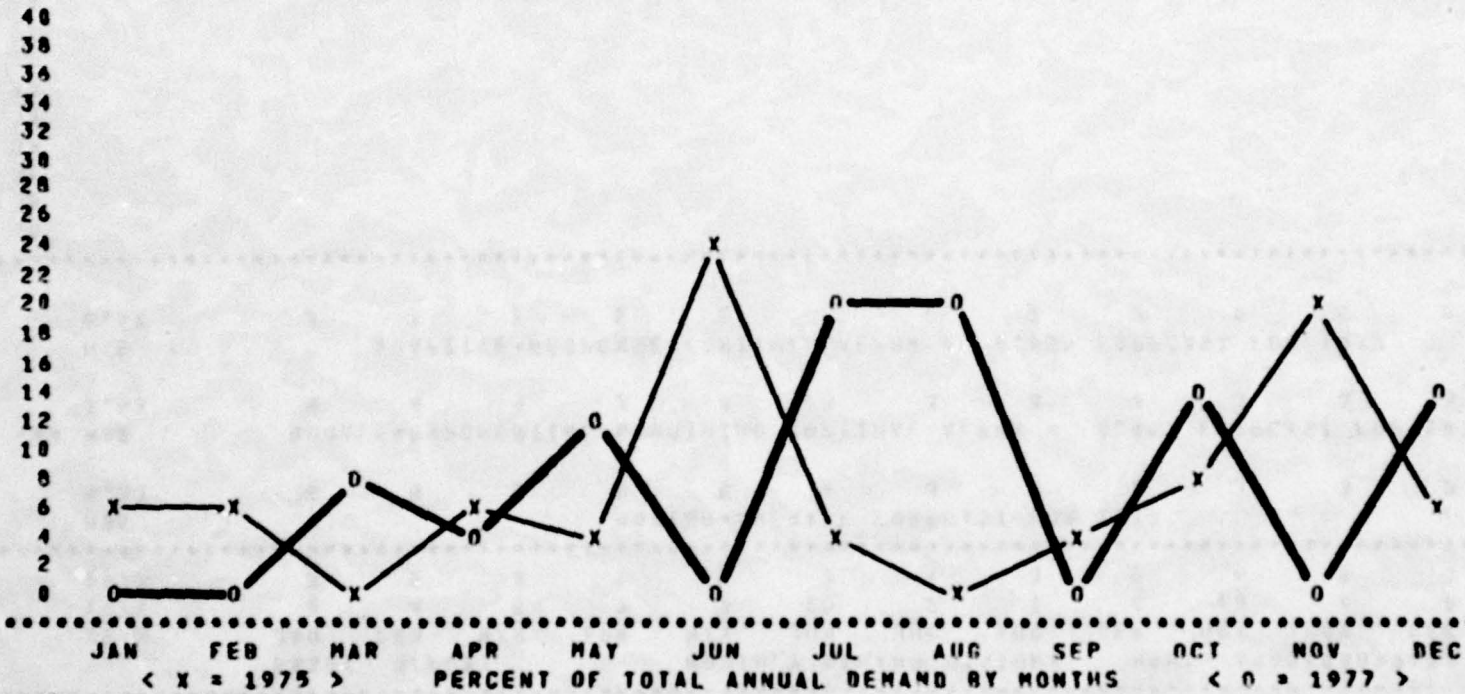
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008542242

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	6	0	6	4	20	4	0	4	0	18	6
1977	0	0	4	2	5	0	9	9	0	4	0	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
20.25	7	6	6	6	6	6	4	5	5	5	5	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
11.92	4	4	4	4	4	4	4	4	4	4	4	4

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
20.83	7	6	5	2	3	2	3	1	4	7	1	2



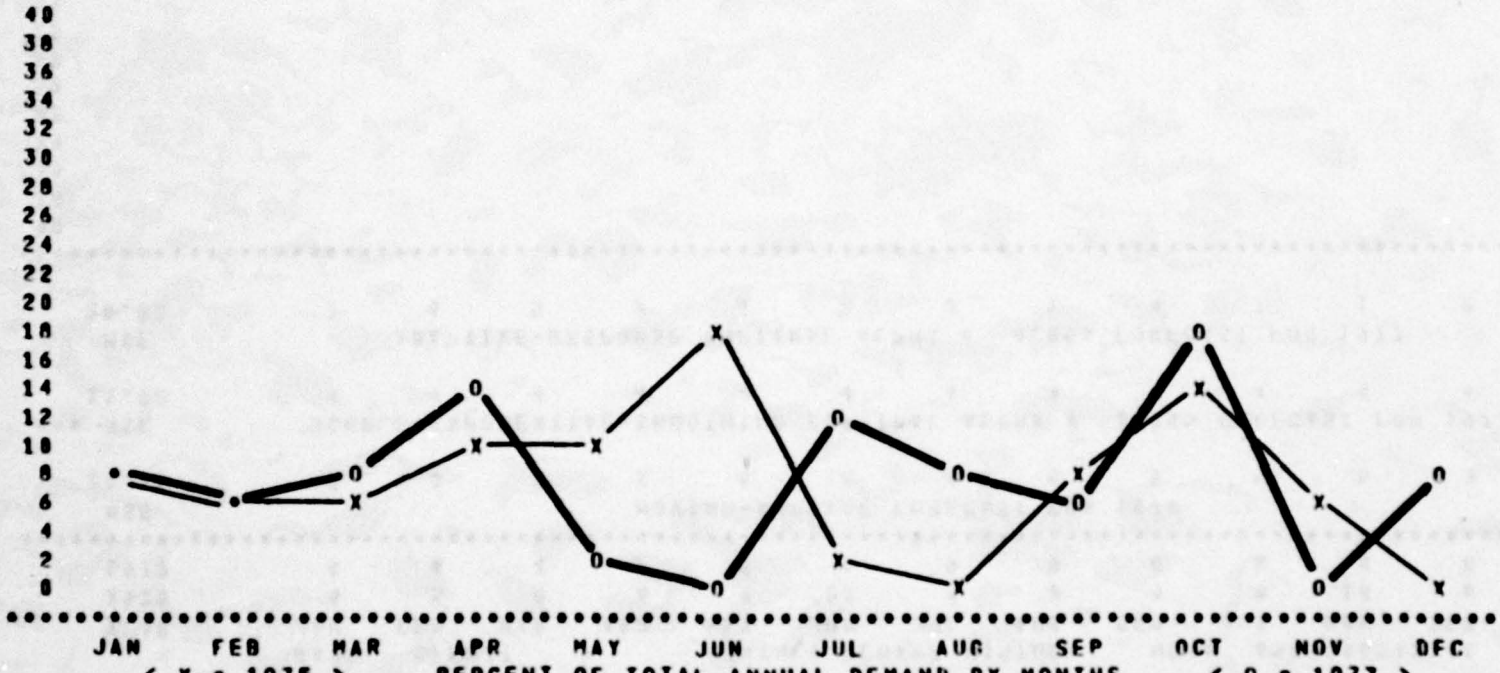
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008899033

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	4	5	7	7	12	2	8	6	10	4	0
1977	3	2	3	5	1	0	4	3	2	6	0	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
5.83	5	5	5	5	5	4	3	3	3	3	3	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
3.83	5	4	4	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
6.67	3	3	2	2	2	1	0	2	2	2	5	0



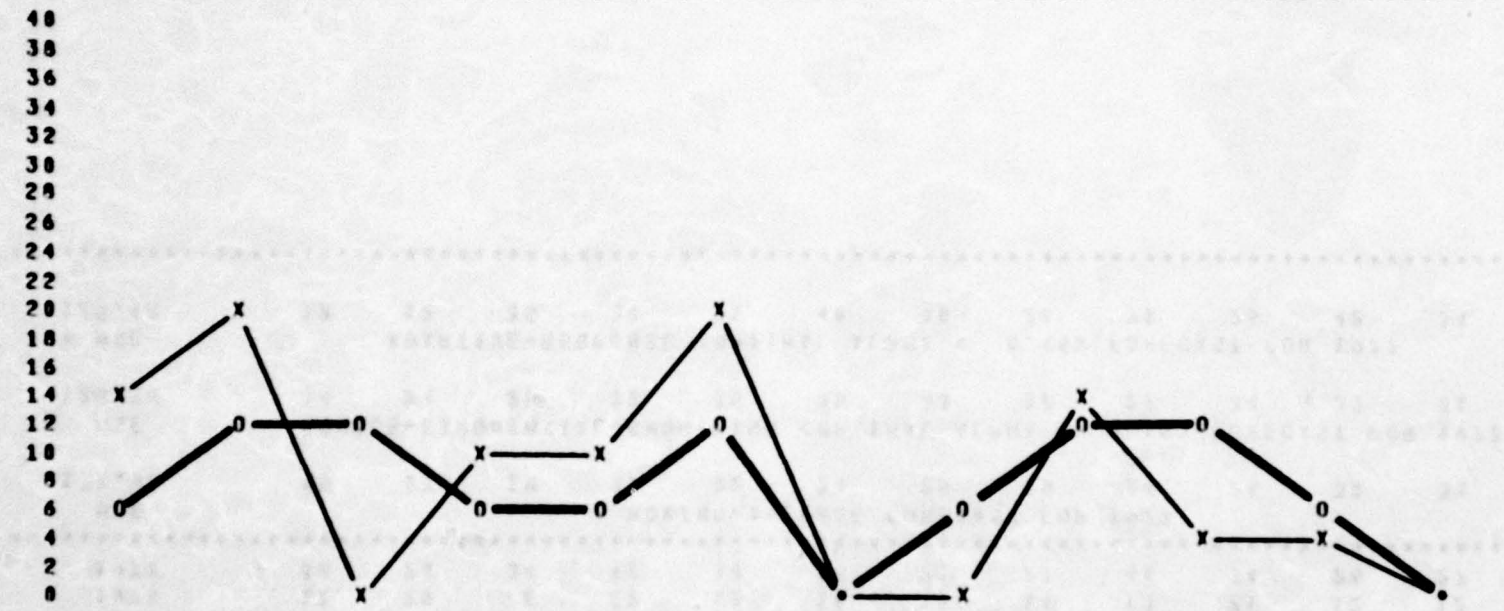
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505008901538

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	4	0	2	2	4	0	0	3	1	1	0
1977	1	2	2	1	1	2	0	1	2	2	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.67	2	2	1	2	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
0.58	2	2	2	2	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
1.25	0	0	1	1	1	1	1	0	0	1	1	1



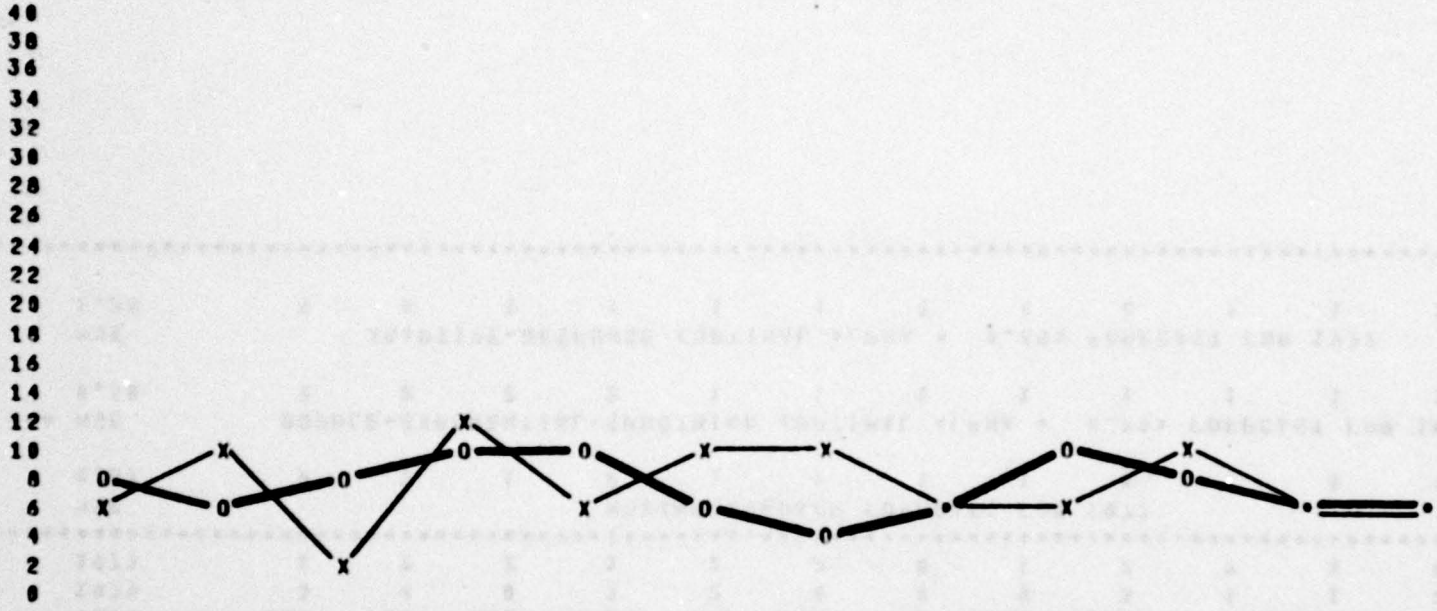
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009010043

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	11	20	6	22	12	18	18	14	13	21	12	12
1977	38	24	34	42	40	26	21	27	44	34	26	27

MSE	MOVING-AVERAGE FORECAST FOR 1977											
171.50	15	17	18	20	22	24	25	25	24	28	30	31

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
128.26	14	24	25	29	35	38	33	27	27	34	35	31

••• MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
125.42	12	12	35	24	31	40	40	26	21	26	42	34



BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009262241

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	72	36	8	66	68	68	48	97	68	48	72	36
1977	36	24	26	42	64	12	30	45	48	36	46	26

MSE	MOVING-AVERAGE FORECAST FOR 1977											
342.17	55	52	51	53	51	51	47	46	41	40	39	37

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
178.25	38	38	38	38	39	39	39	39	39	39	39	39

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
247.58	49	64	43	26	25	40	48	19	23	23	37	36

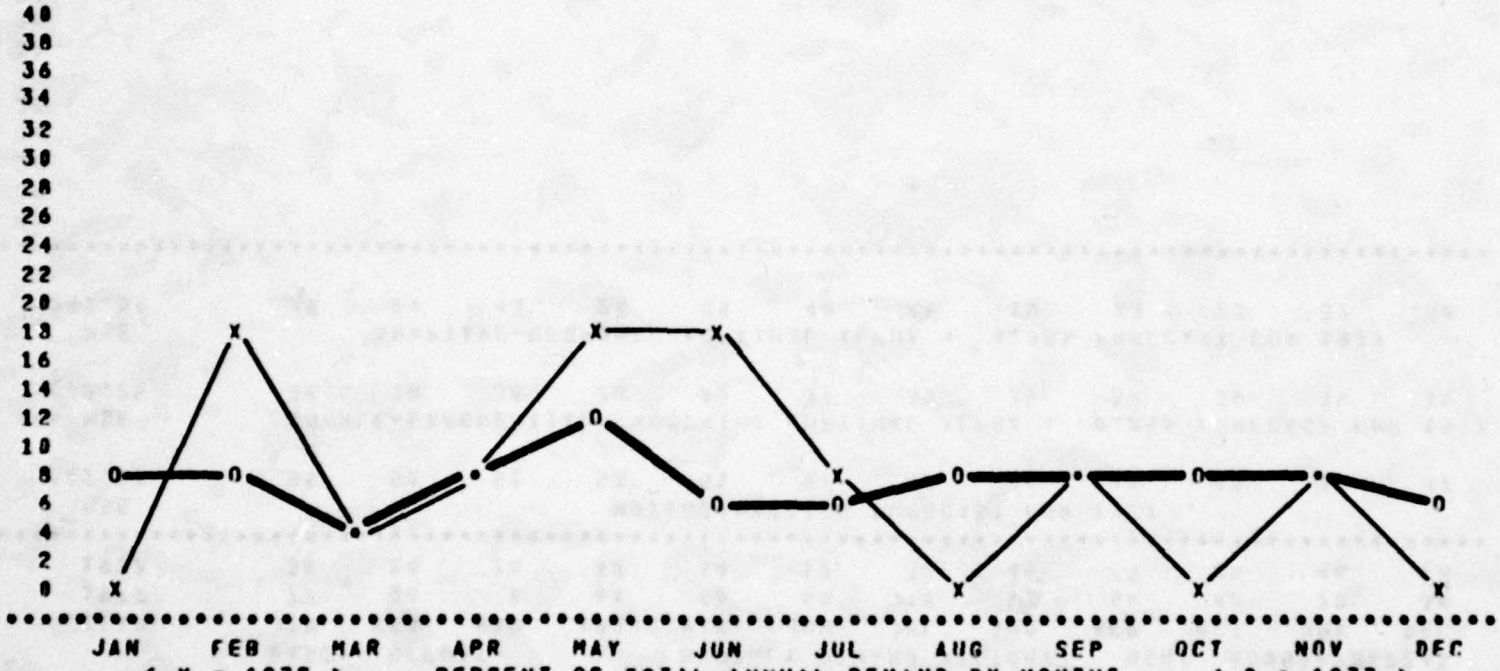
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009269089

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	24	6	12	24	24	12	0	12	0	12	0
1977	16	15	10	16	22	12	12	16	17	15	17	13

MSE					MOVING-AVERAGE FORECAST FOR 1977							
19.17	11	12	11	11	12	12	11	11	12	12	14	14

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
22.00	10	10	10	10	11	12	12	12	13	13	14	14

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977											
17.67	10	14	14	12	14	17	12	12	12	15	15	16



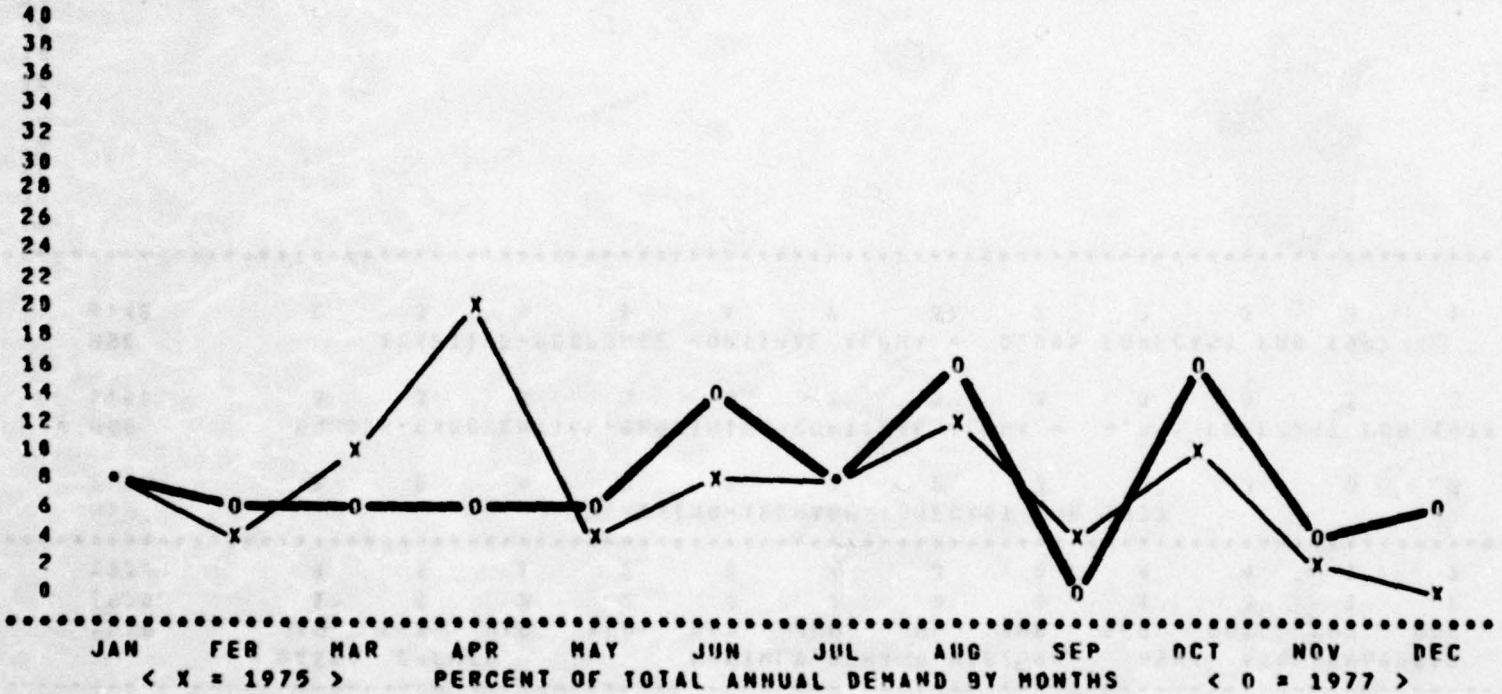
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009355859

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	3	7	14	4	6	6	9	3	8	2	8
1977	8	7	7	6	7	14	9	16	8	16	4	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
25.92	6	6	6	6	6	6	6	7	7	7	8	8

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
25.75	6	6	6	6	6	6	6	7	8	8	8	8

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
38.58	1	8	7	7	7	6	6	13	9	14	8	15



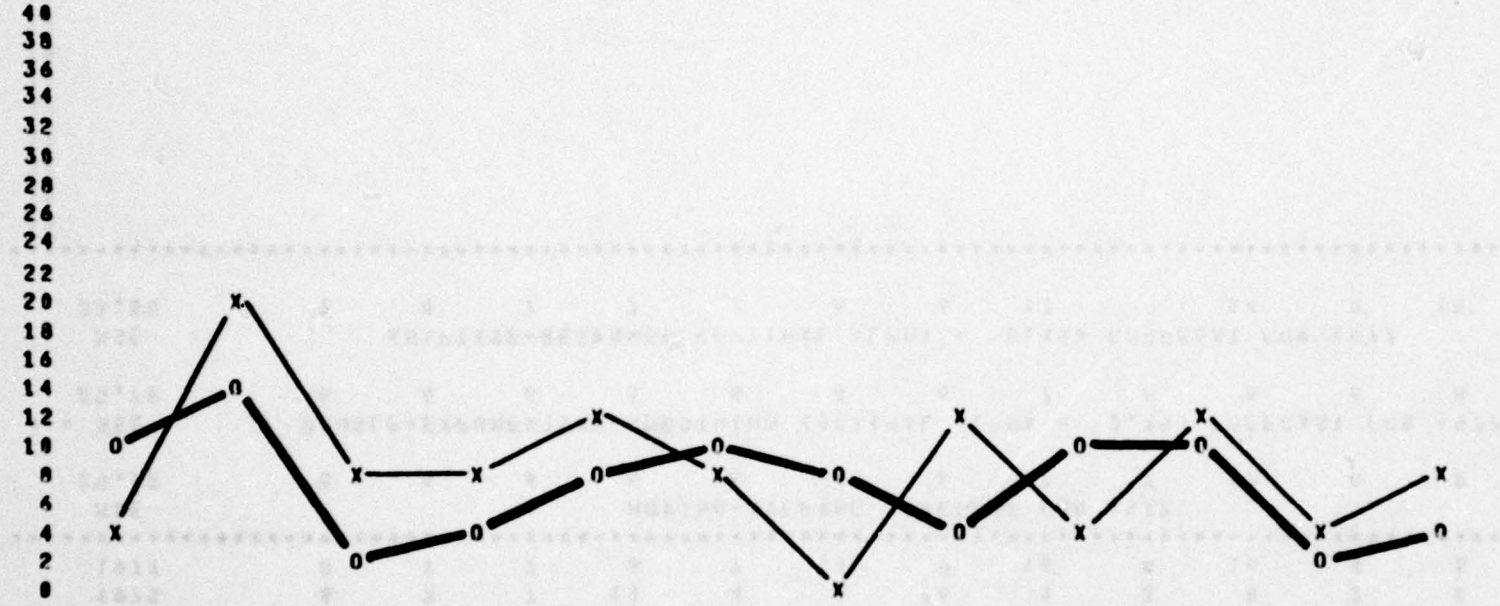
BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009652512

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	5	2	2	3	2	0	3	1	3	1	2
1977	4	5	1	2	3	4	3	2	4	4	1	?

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.33	2	2	2	2	2	2	2	3	3	3	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.58	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977											
3.42	1	3	4	1	1	2	3	2	2	3	3	1



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

BASE: OFFUTT MONTHLY DEMAND HISTORY NSN: 6505009857381

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	57	8	2	4	4	26	18	18	29	34	40	13
1977	21	14	12	5	8	13	9	13	2	16	22	11

MSE	MOVING-AVERAGE FORECAST FOR 1977											
68.17	20	17	18	19	19	19	18	17	18	15	14	12

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
45.43	22	21	16	13	8	8	11	10	12	6	12	19

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
28.75	15	13	20	17	13	5	7	9	9	12	2	14

APPENDIX G

COMPUTER PRODUCTS, NONSEASONAL (WHITEMAN)

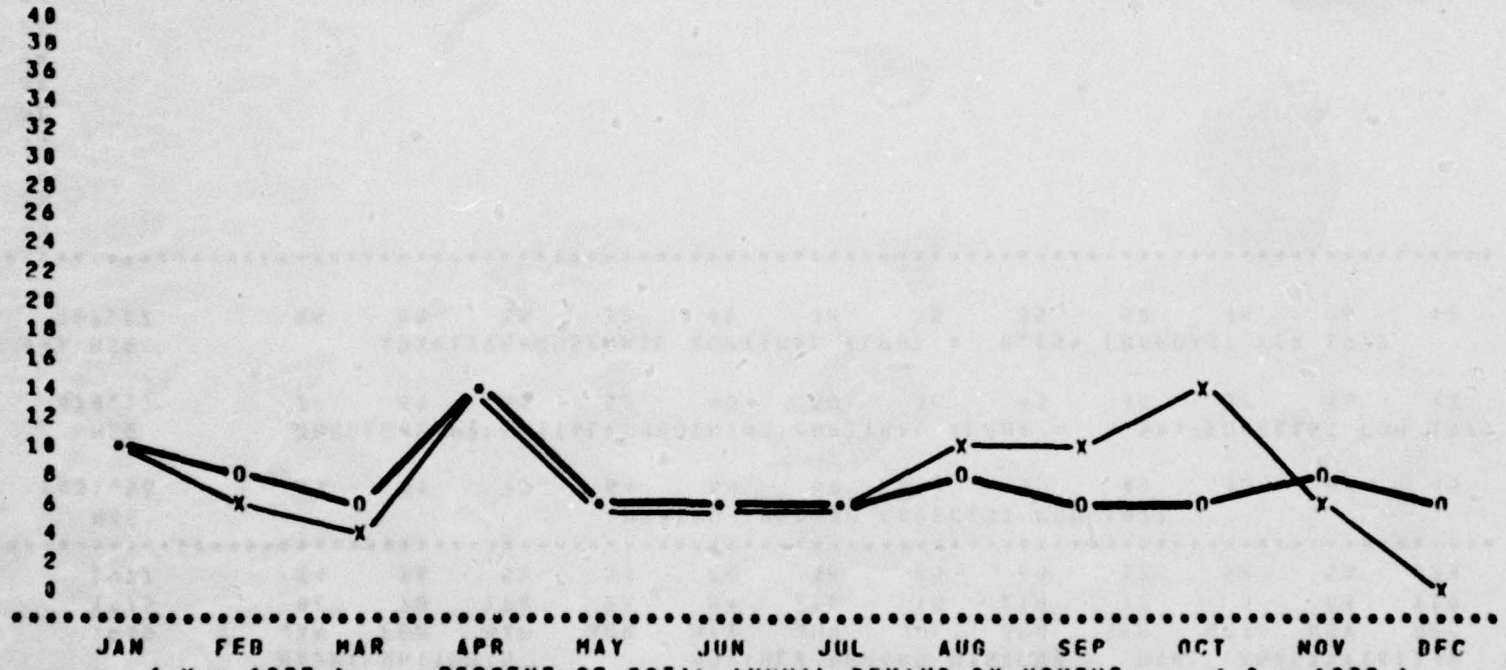
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008835616

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	4	3	9	4	4	4	7	6	9	4	8
1977	9	7	5	12	6	5	5	7	6	5	7	5

MSE	MOVING-AVERAGE FORECAST FOR 1977											
5.25	5	5	6	6	6	6	6	6	6	6	6	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
5.17	5	5	5	6	6	6	6	6	6	6	6	6

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
8.00	3	6	6	5	5	5	5	5	6	6	5	5



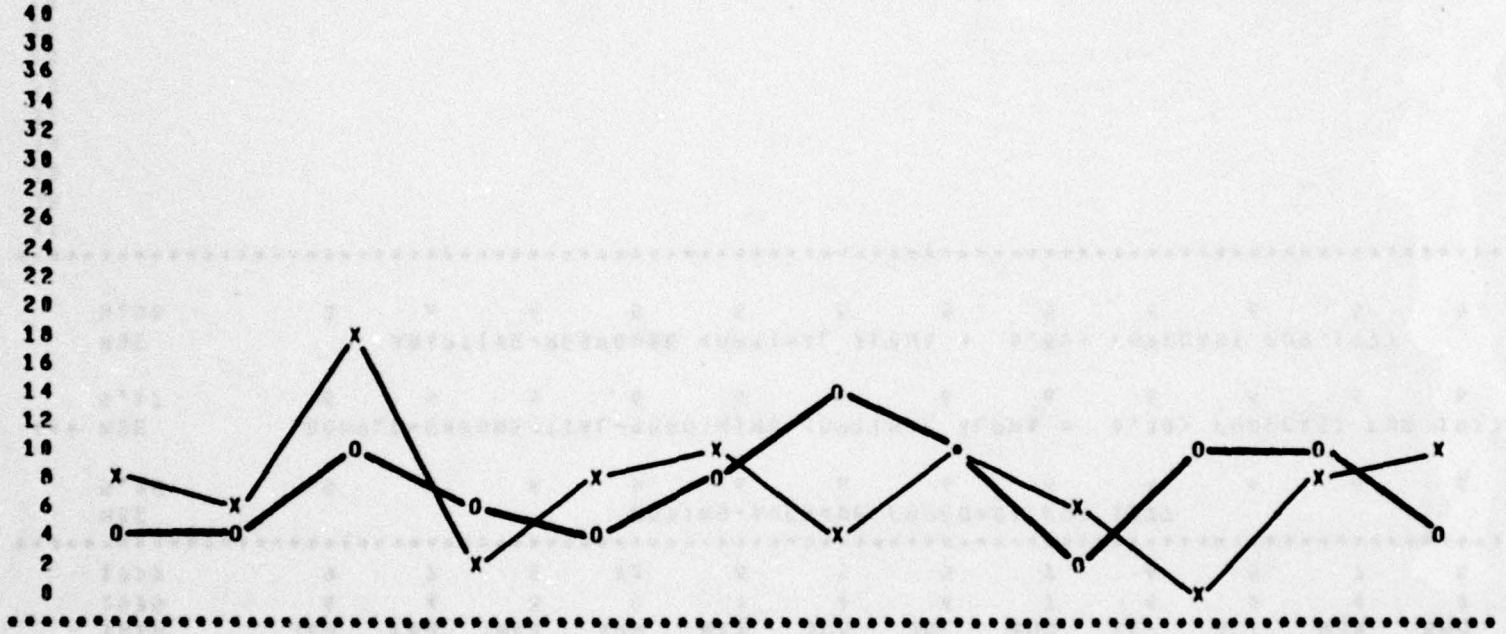
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001161740

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	82	78	190	26	84	110	48	118	77	0	84	118
1977	24	26	58	34	24	36	65	48	12	52	50	24

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1031.58	85	80	75	64	64	59	53	55	49	43	48	45

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.50) FORECAST FOR 1977											
674.17	78	68	55	50	45	39	36	43	46	38	40	43

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.15) FORECAST FOR 1977											
367.17	56	88	36	32	41	38	35	35	50	48	26	47



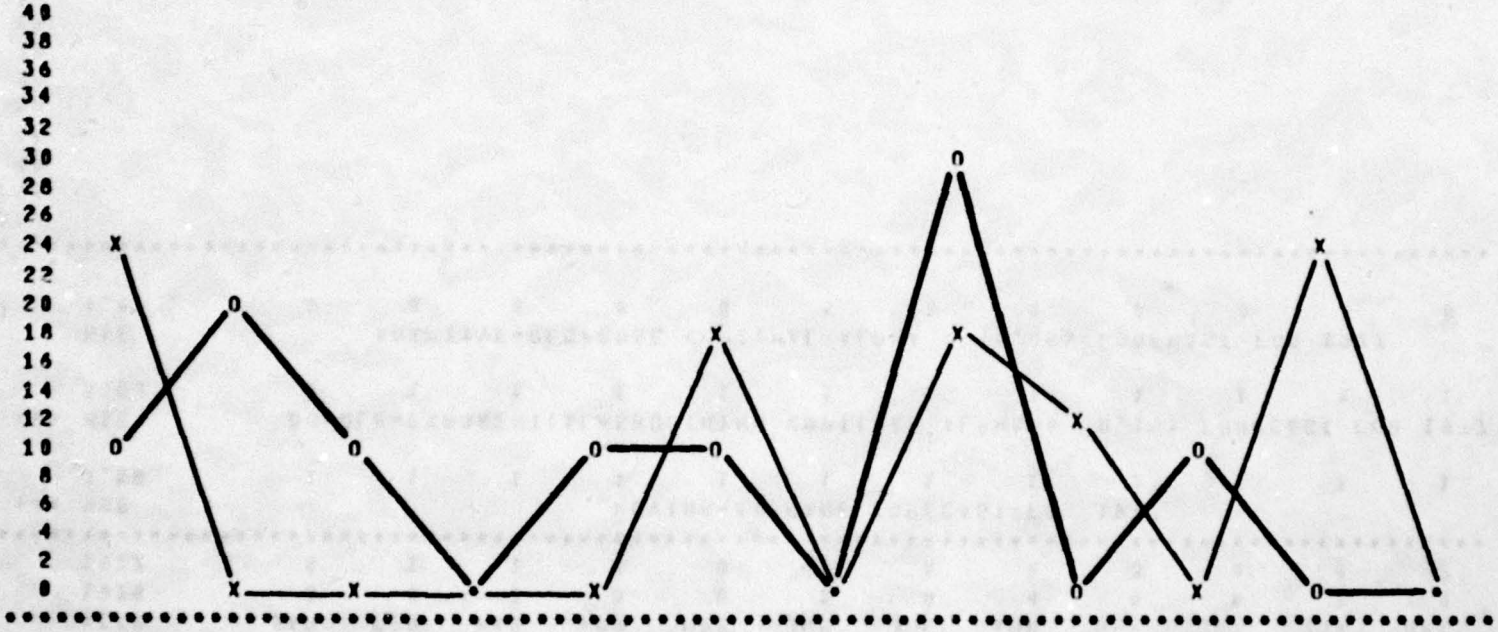
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001316420

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	6	0	6	4	0	0	0
1977	1	2	1	0	1	1	0	3	0	1	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.00	3	2	2	2	2	2	2	2	2	1	2	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
1.42	3	2	2	2	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.17	1	0	0	1	1	0	0	0	0	2	0	0



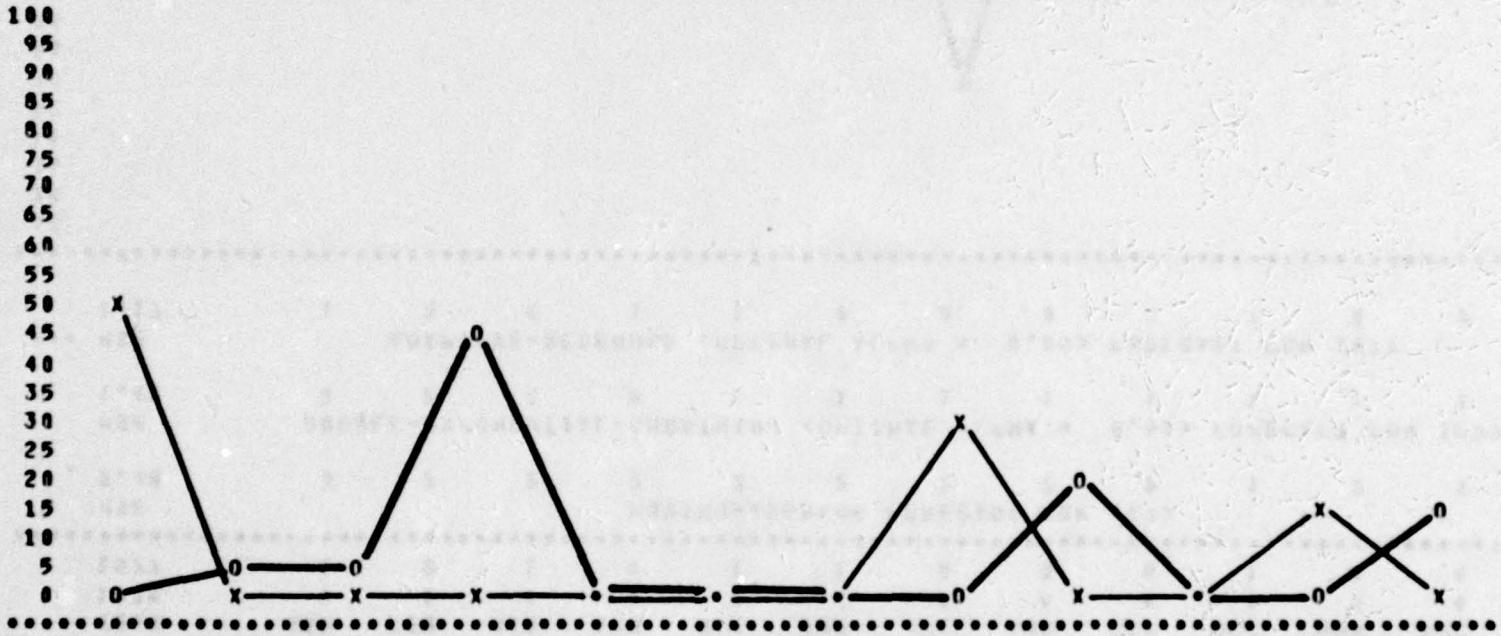
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001405158

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	0	0	0	0	0	0	4	0	0	2	0
1977	0	1	1	6	0	0	0	0	3	0	0	2

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3.08	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
3.08	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
4.42	0	0	0	0	0	5	0	0	0	0	0	0



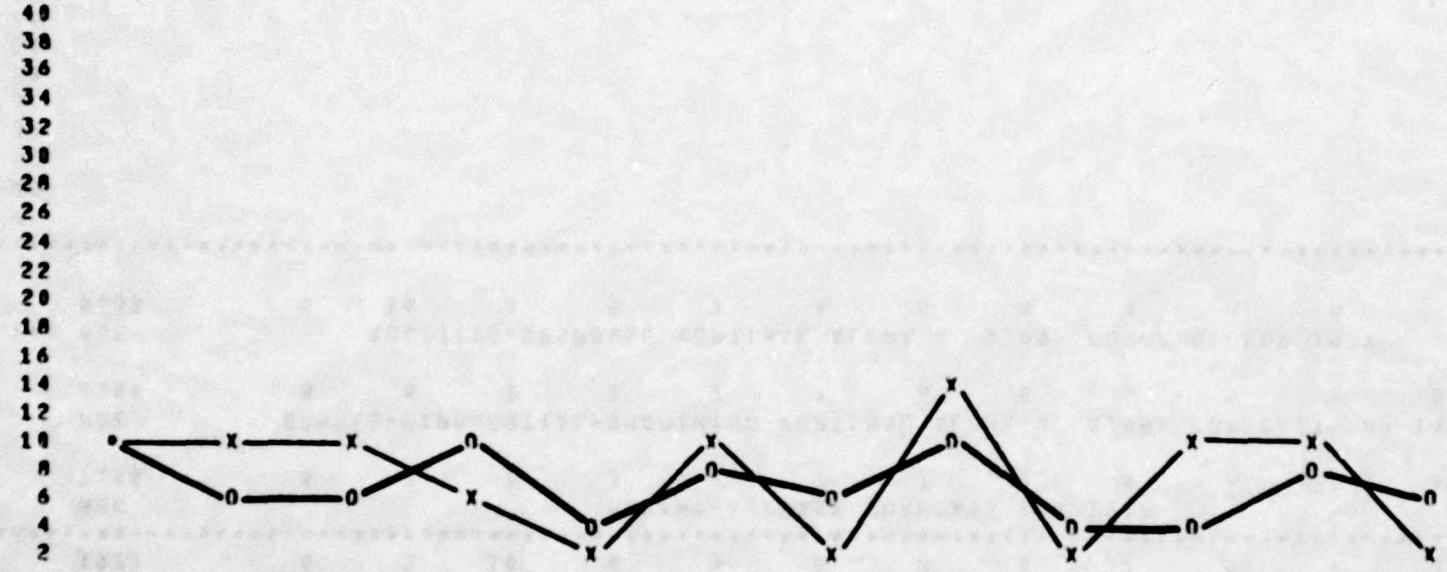
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001450429

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	110	96	100	60	36	90	36	132	24	100	103	25
1977	72	48	48	72	36	60	48	72	36	36	60	48

MSE	MOVING-AVERAGE FORECAST FOR 1977											
304.92	77	74	70	66	67	67	63	64	59	60	55	51

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
225.50	71	68	62	57	60	54	54	53	57	53	48	49

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
298.88	77	80	74	53	48	70	57	58	54	66	53	43



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

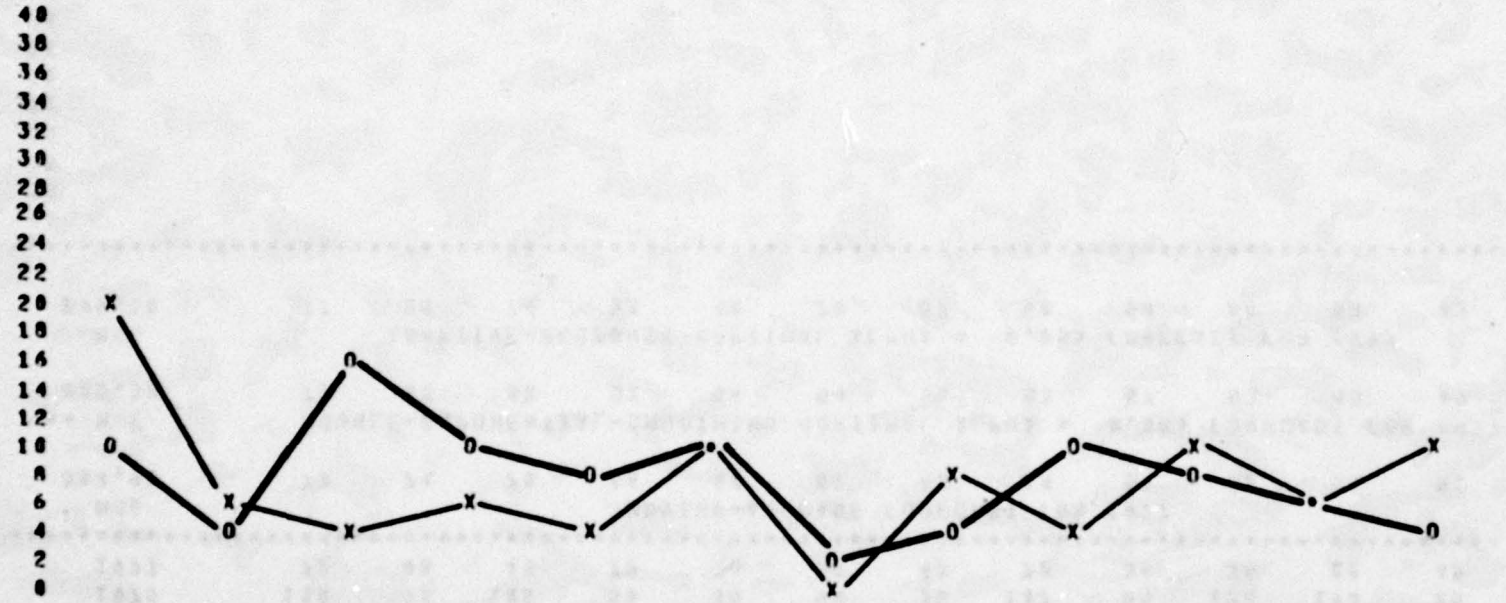
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001538758

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	21	4	5	7	4	11	1	9	4	11	7	11
1977	6	3	10	6	5	6	2	3	7	5	4	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
7.58	8	7	7	7	7	7	7	7	6	6	6	6

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.45) FORECAST FOR 1977											
6.88	8	8	7	7	7	7	6	5	5	5	5	5

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
5.83	5	10	6	5	7	6	5	5	4	3	6	5



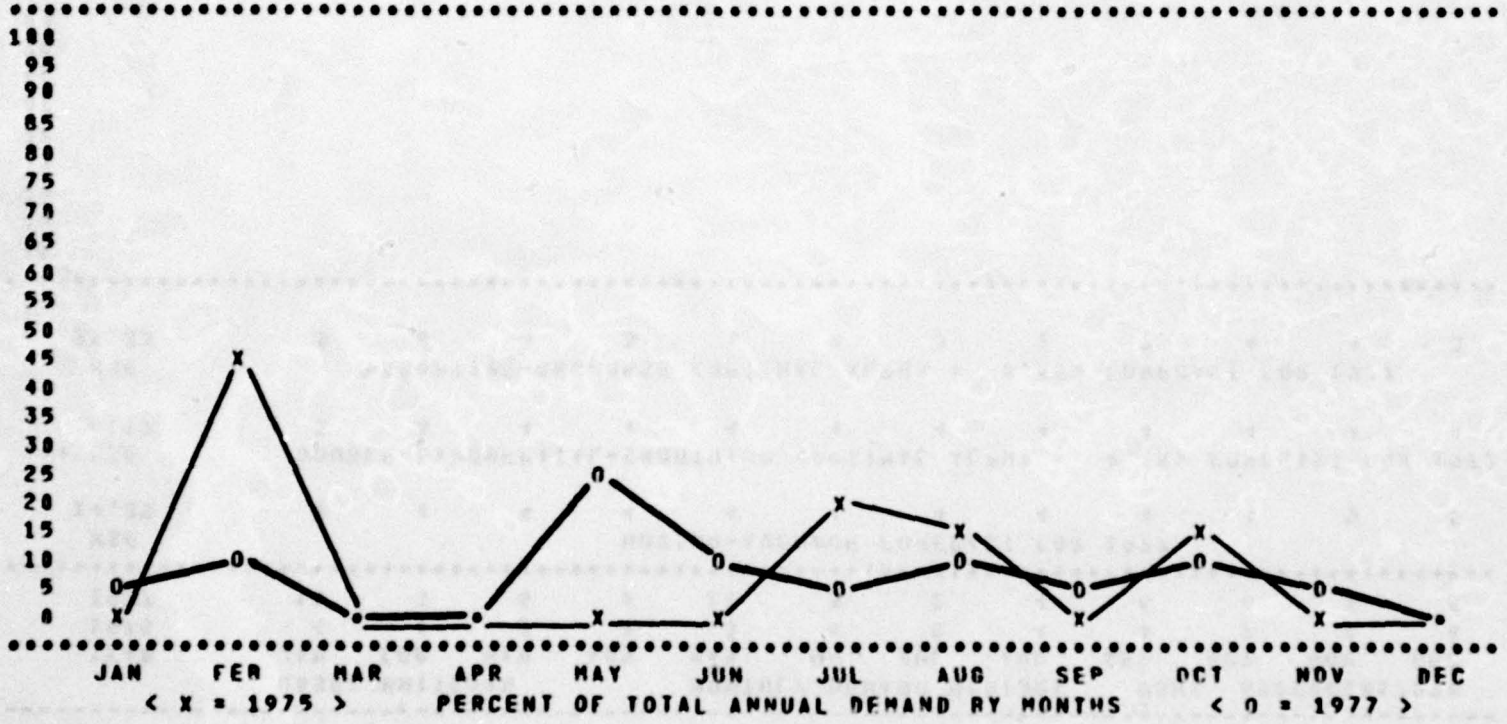
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001601500

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	0	0	0	0	3	2	0	2	0	0
1977	1	2	0	0	4	2	1	2	1	2	1	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.33	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.15) FORECAST FOR 1977											
1.33	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
2.88	0	0	0	1	0	0	0	1	1	1	1	1



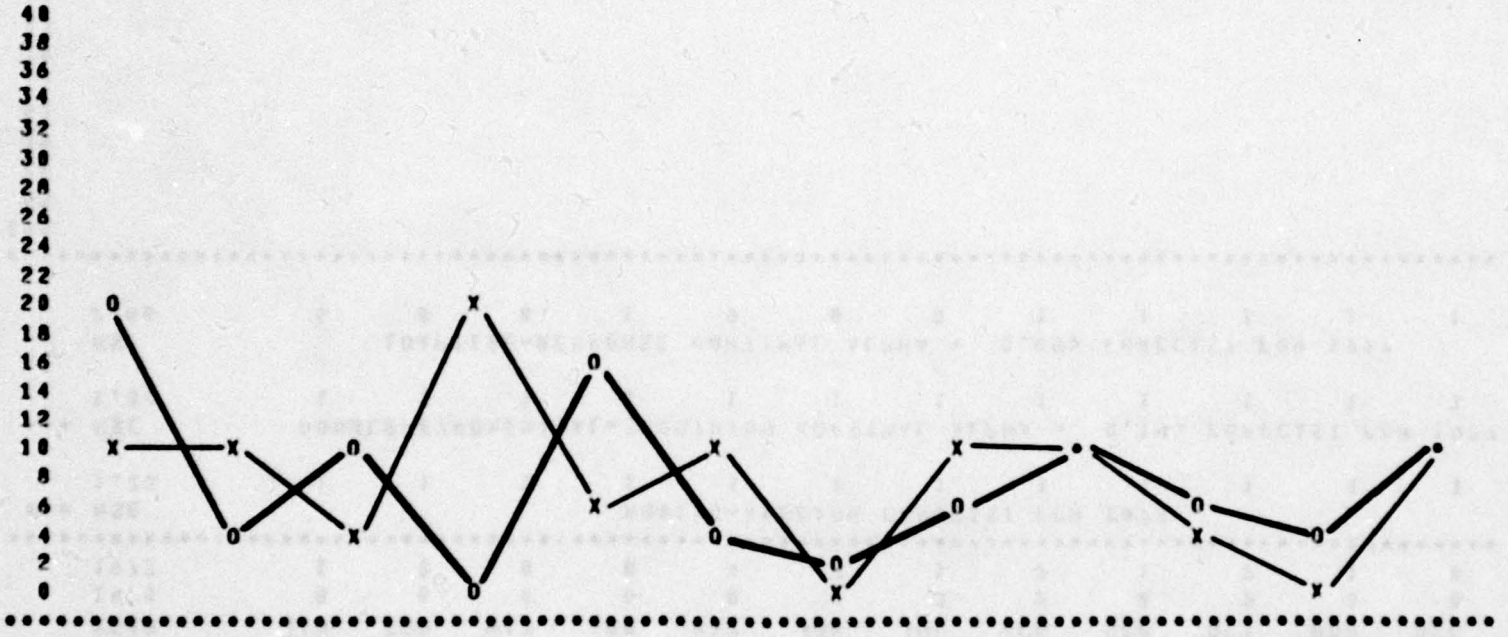
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001817296

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	4	2	8	3	4	8	4	4	2	8	4
1977	13	3	6	8	10	3	2	4	6	4	3	6

MSE	MOVING-AVERAGE FORECAST FOR 1977											
14.25	3	4	4	4	4	4	4	4	4	4	5	5

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
14.17	3	3	4	4	4	4	4	4	4	4	4	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
21.33	3	8	3	3	1	4	3	2	2	4	4	3



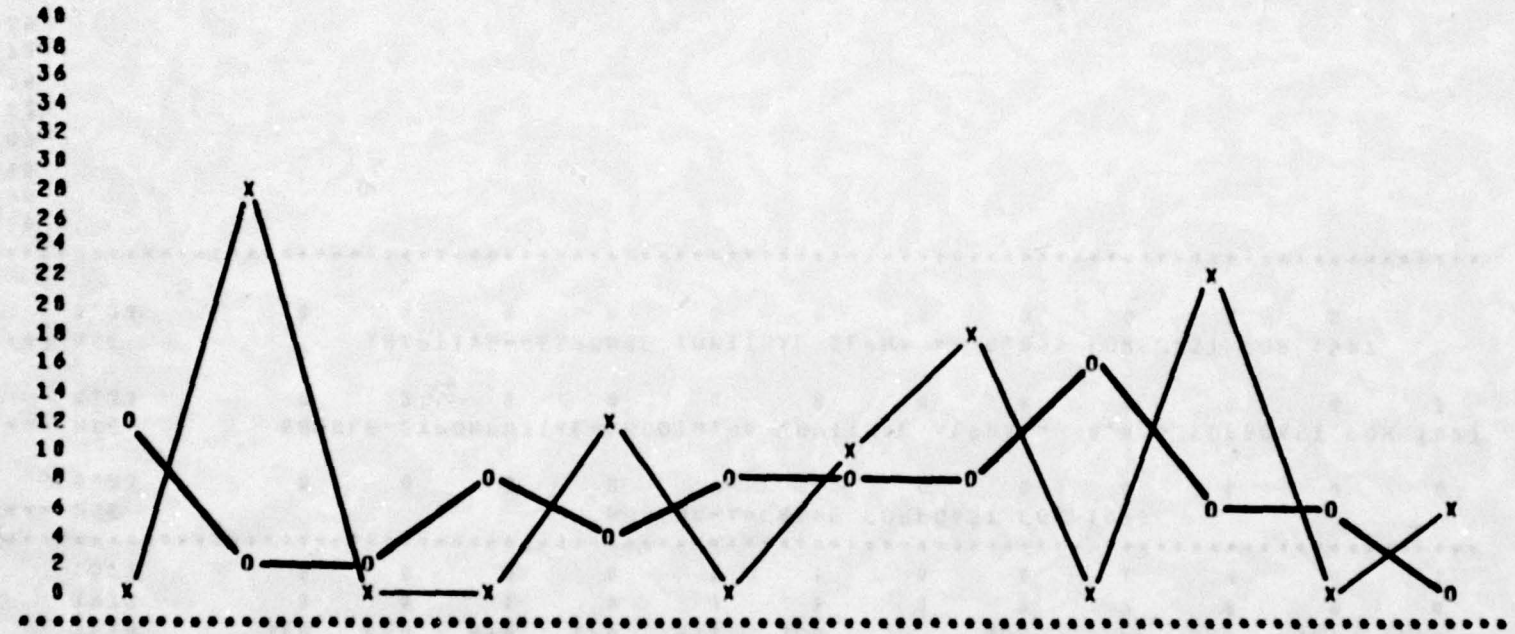
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505002865349

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	27	0	0	12	0	10	10	0	22	0	6
1977	14	4	4	10	6	9	10	10	10	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
21.92	8	9	7	8	8	8	9	9	8	9	8	9

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
20.75	8	8	8	8	8	8	8	8	8	8	8	8

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
29.88	4	2	10	4	4	4	5	8	9	9	17	8



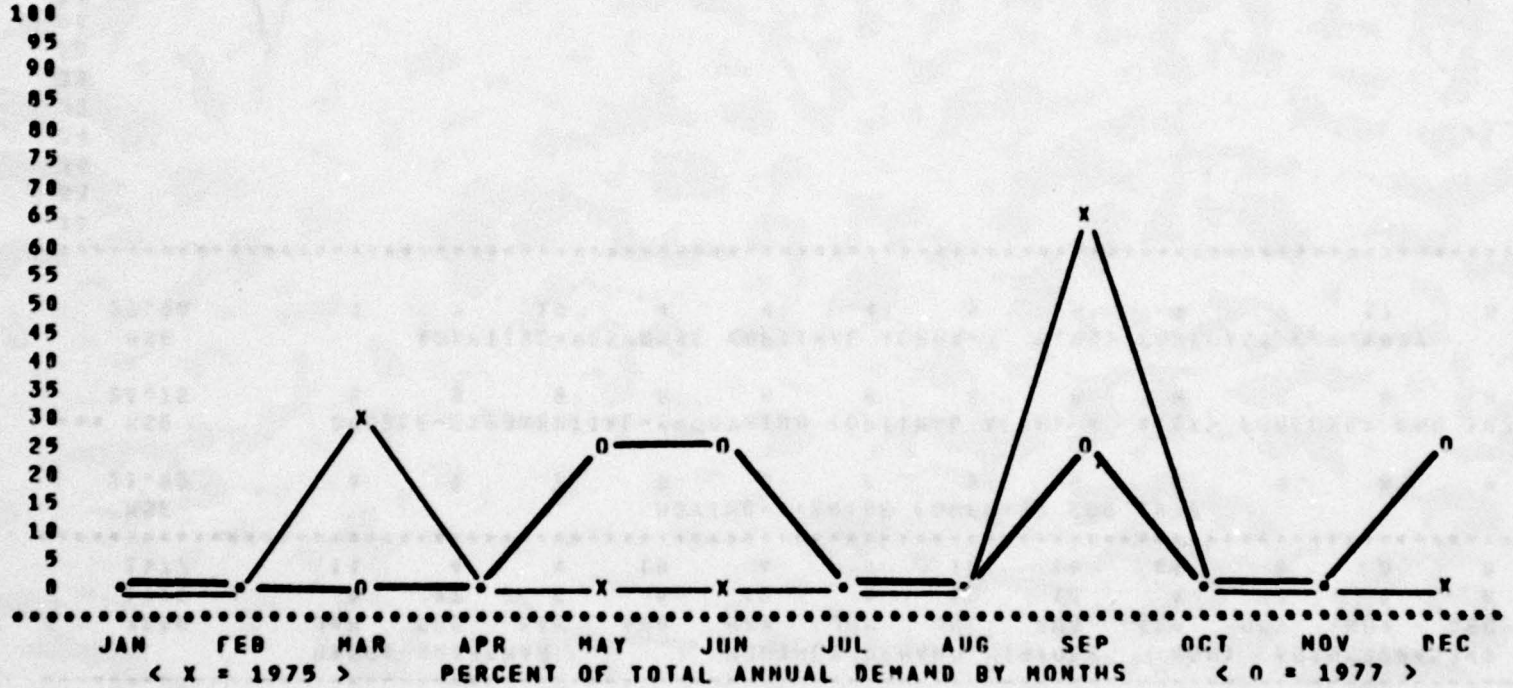
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505002998617

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	1	0	0	0	0	0	2	0	0	0
1977	0	0	0	0	1	1	0	0	1	0	0	1

MSE					MOVING-AVERAGE FORECAST FOR 1977							
0.33	0	0	0	0	0	0	0	0	0	0	0	0

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
0.33	0	0	0	0	0	0	0	0	0	0	0	0

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
0.33	0	0	0	0	0	0	0	0	0	0	0	0



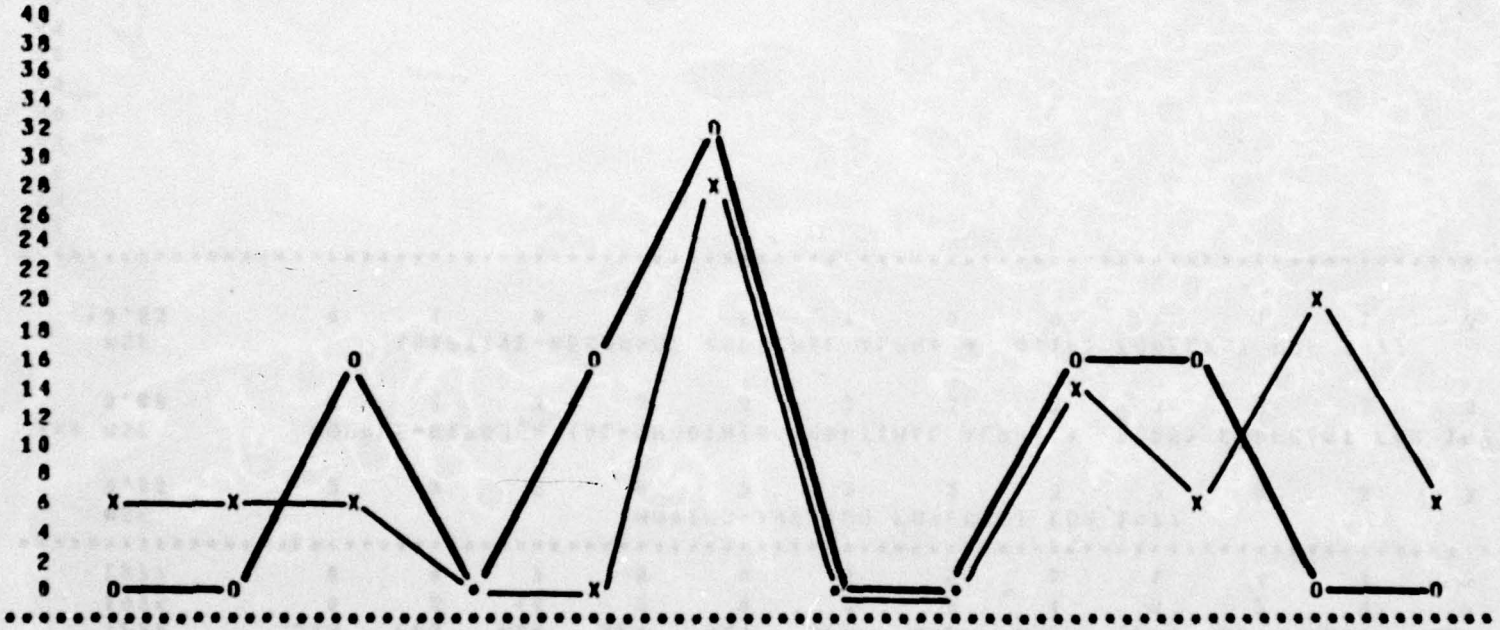
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005386478

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	1	1	0	0	4	0	0	2	1	3	1
1977	0	0	1	0	1	2	0	0	1	1	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
0.67	1	1	1	1	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
0.67	1	1	1	1	1	1	1	1	1	1	1	1

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
0.83	1	1	0	0	0	0	0	1	0	0	0	0



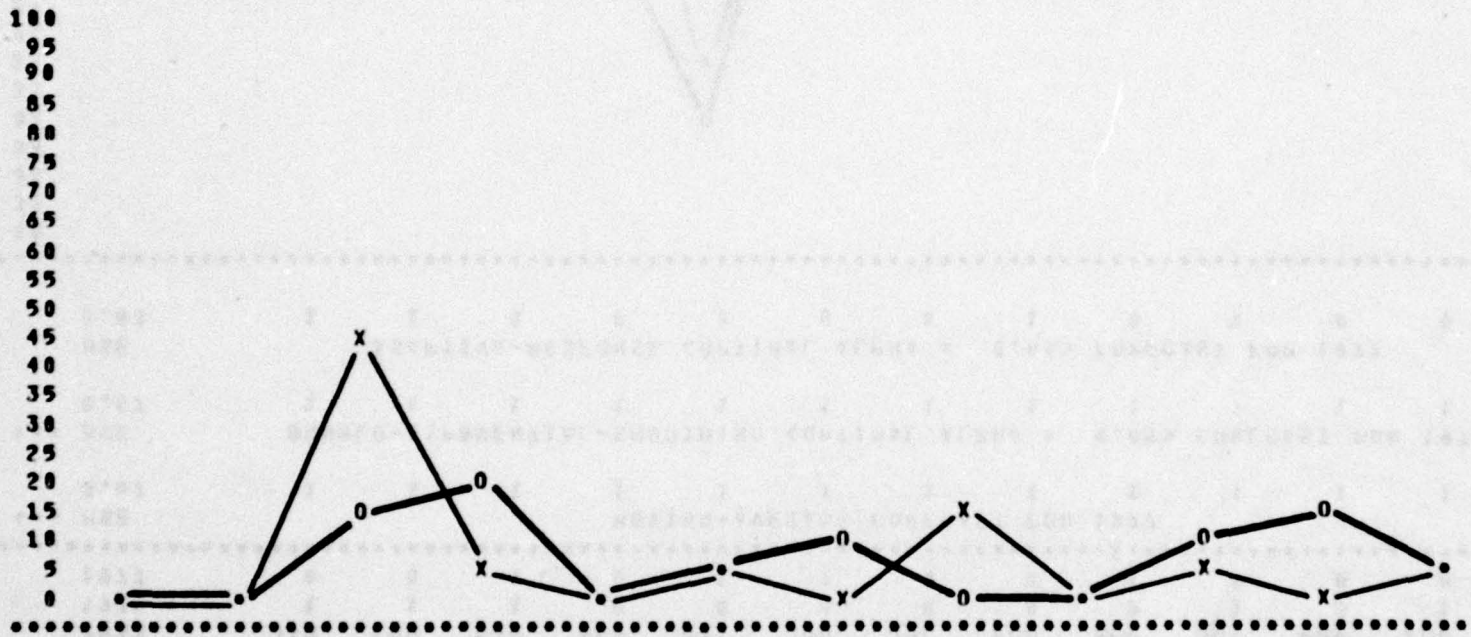
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005825378

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	10	2	0	2	0	4	0	2	0	2
1977	0	0	7	8	0	3	5	1	1	4	7	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
9.00	2	2	2	2	2	2	2	3	2	2	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
8.88	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
13.83	0	1	0	0	0	7	0	0	1	1	1	3



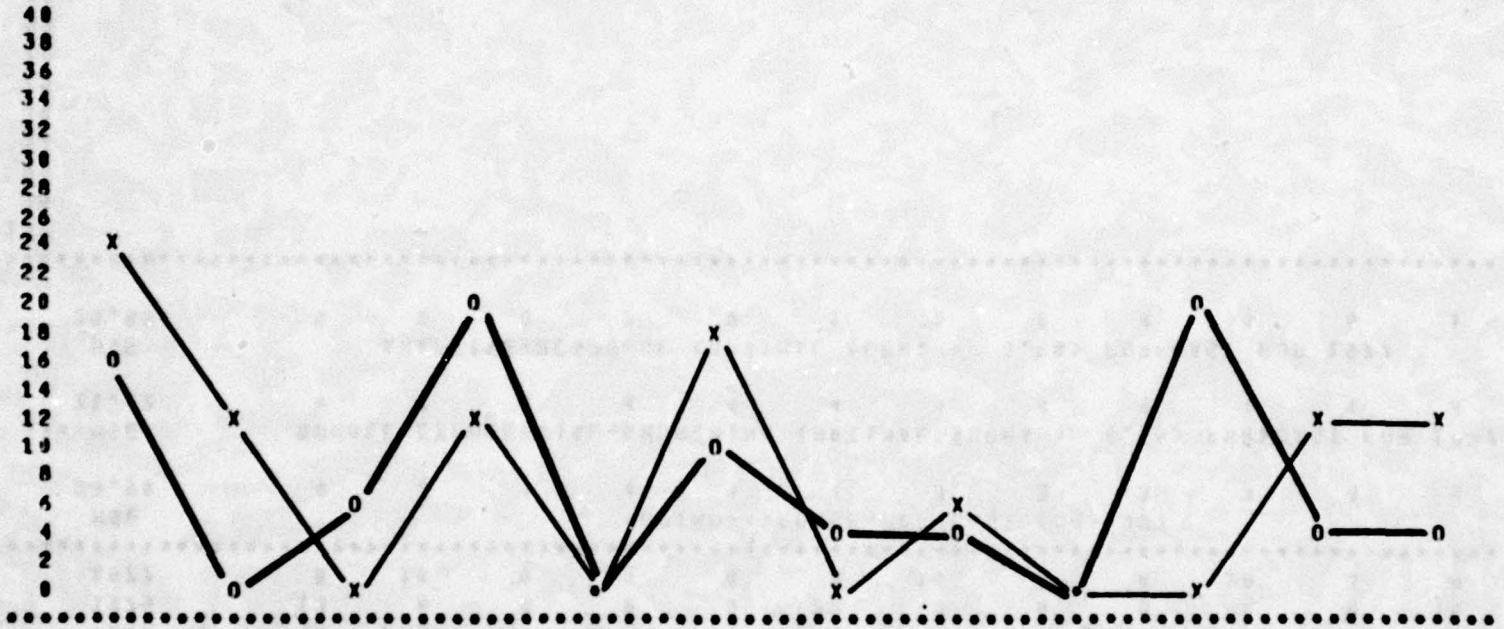
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505005843470

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	40	20	0	20	0	30	0	10	0	0	20	20
1977	15	1	6	20	0	10	5	5	0	20	5	5

MSE	MOVING-AVERAGE FORECAST FOR 1977											
49.50	13	11	10	10	10	10	9	9	9	9	10	9

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
54.25	12	12	11	11	11	11	10	10	9	8	8	8

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
66.50	14	10	16	14	8	10	12	10	6	5	8	10



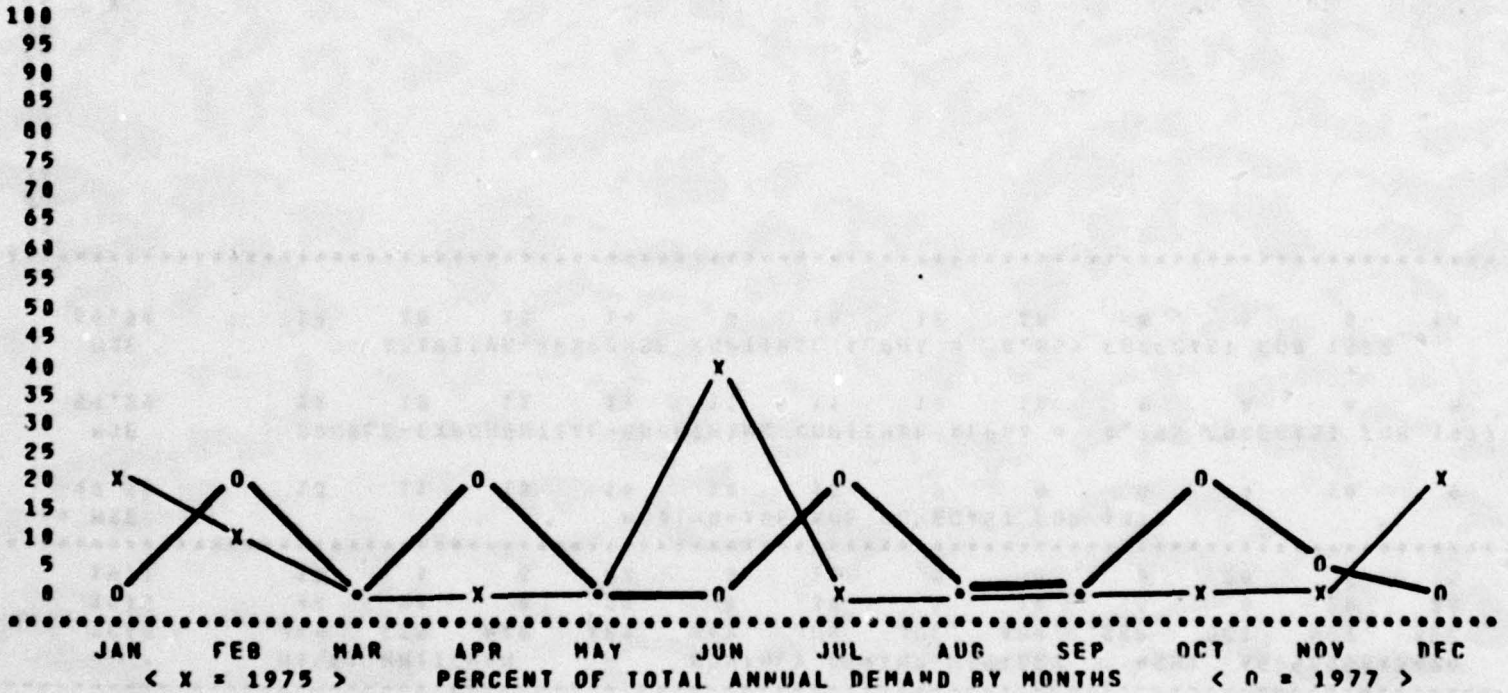
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006198628

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	6	0	0	0	22	0	0	0	0	0	10
1977	0	10	0	10	0	0	10	0	0	10	3	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
23.50	4	3	4	4	4	4	3	3	3	3	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
21.42	4	4	4	4	4	4	4	4	4	4	4	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
25.83	5	5	0	?	0	1	0	0	4	0	0	1



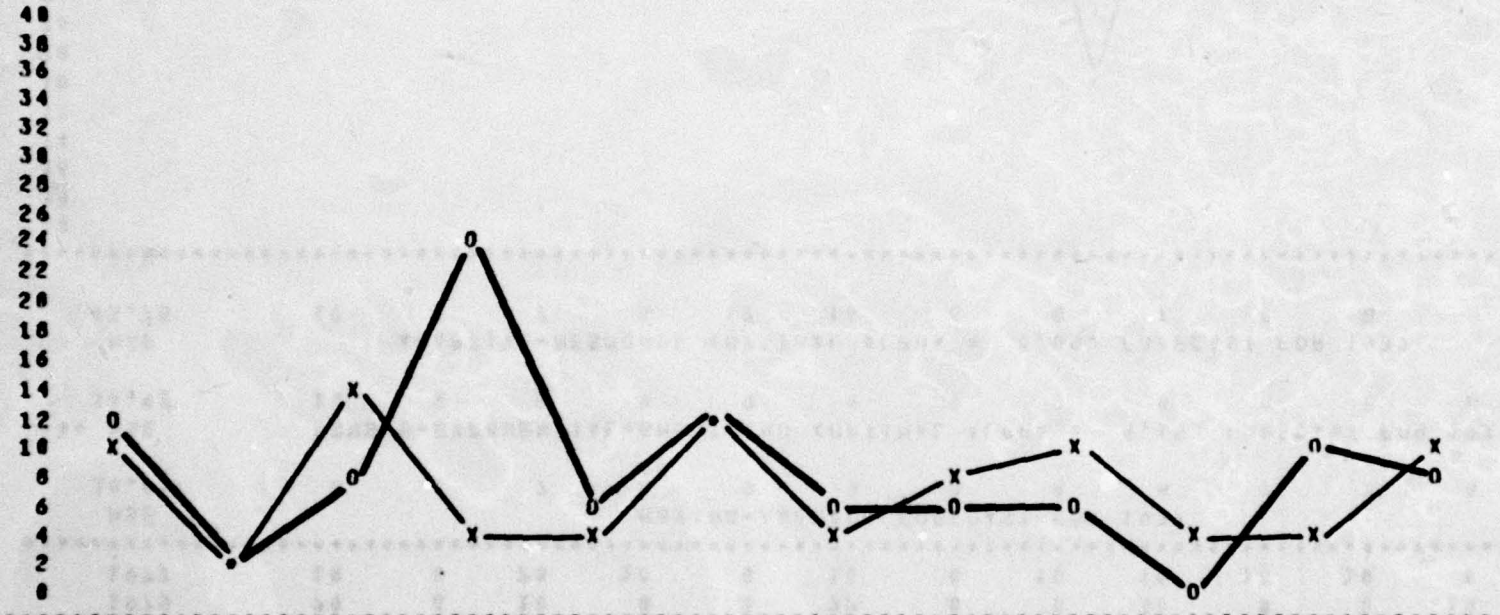
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006000133

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	9	2	11	4	4	9	3	6	8	4	3	7
1977	6	1	4	12	3	6	3	3	3	0	5	4

MSE	MOVING-AVERAGE FORECAST FOR 1977											
10.42	6	6	6	5	6	6	5	5	5	5	4	4

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
9.58	6	6	5	5	5	5	6	5	5	4	4	4

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
12.92	3	3	5	1	1	5	.3	4	3	3	3	2



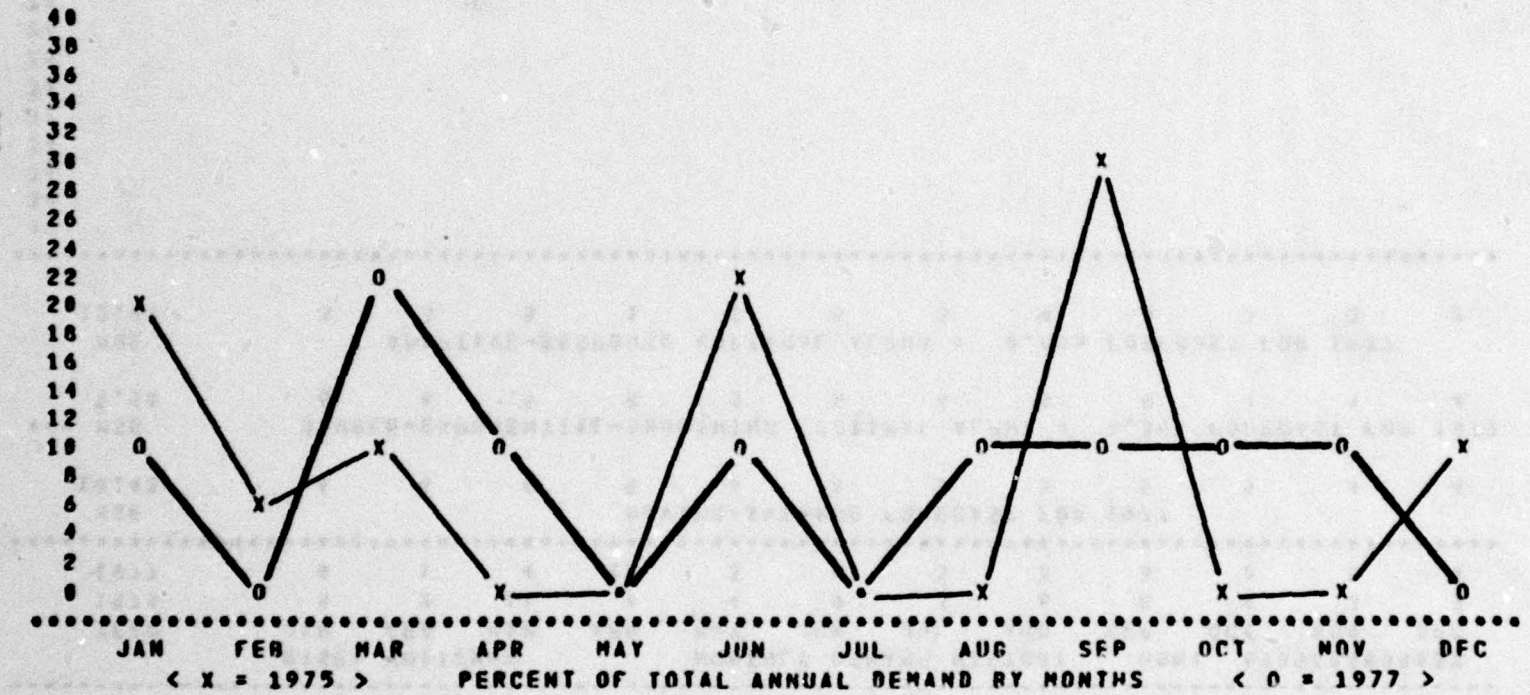
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505006873662

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	20	6	10	0	0	22	0	0	30	0	0	10
1977	10	0	20	10	0	10	0	10	10	10	10	0

MSE				MOVING-AVERAGE FORECAST FOR 1977								
38.88	8	7	7	8	9	9	8	8	8	7	8	8

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977											
36.92	10	9	9	9	9	9	9	9	8	8	8	8

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
43.75	10	7	7	5	12	10	6	8	7	8	8	8



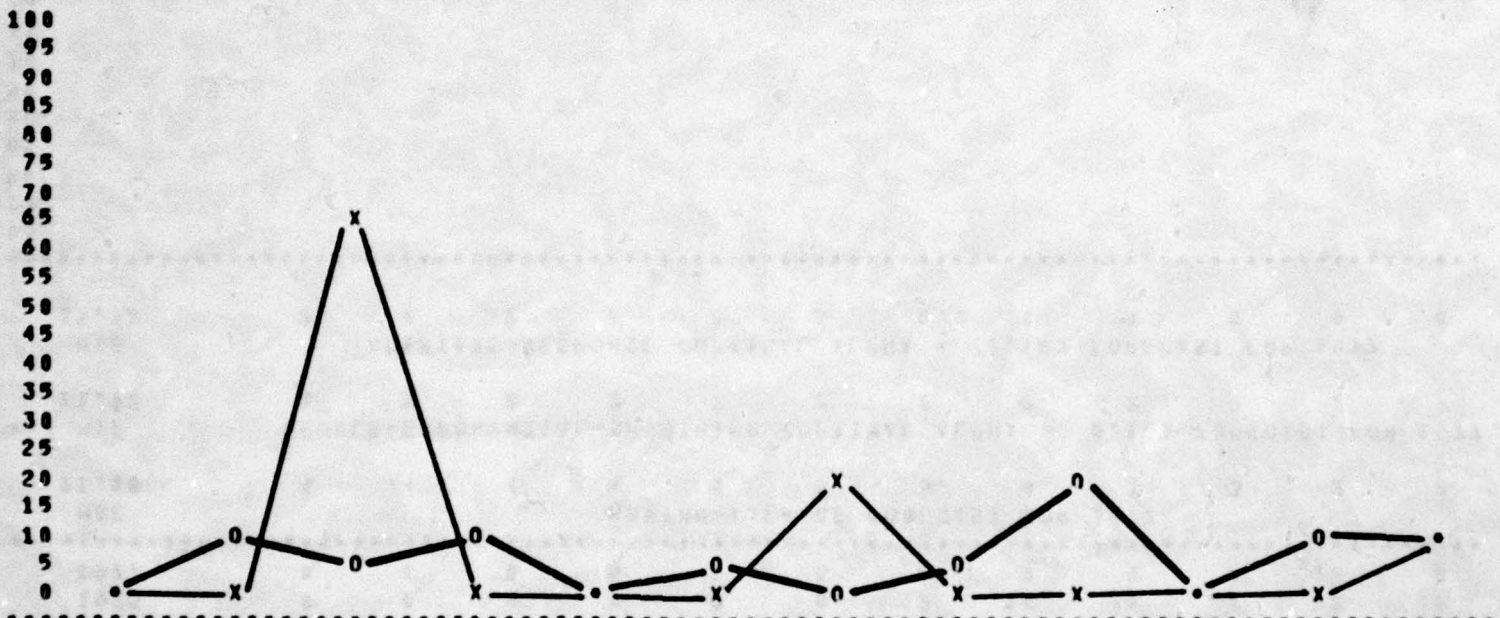
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505007540374

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	6	0	0	0	2	0	0	0	0	1
1977	1	3	2	3	1	2	1	2	6	1	3	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
3.25	1	1	1	1	1	1	1	1	1	2	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
2.88	2	2	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
4.42	0	0	0	2	2	2	1	1	1	1	5	1



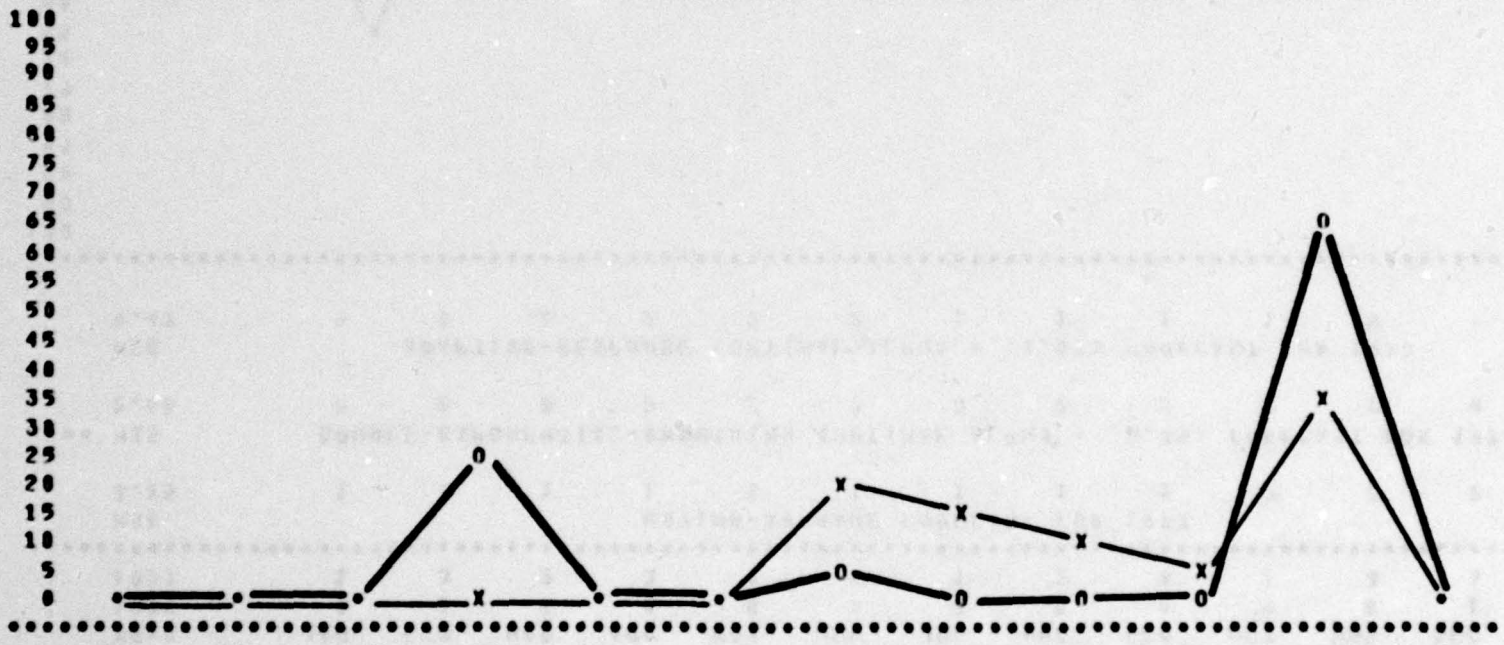
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 4505007054357

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	9	0	0	0	0	0	12	10	6	4	20	0
1977	0	0	0	5	0	0	1	0	0	0	12	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
21.00	4	4	4	4	5	5	5	4	3	3	2	2

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.10) FORECAST FOR 1977											
11.92	1	2	2	2	2	2	2	2	2	2	2	2

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.10) FORECAST FOR 1977											
15.33	2	4	2	0	0	3	0	0	0	0	0	0



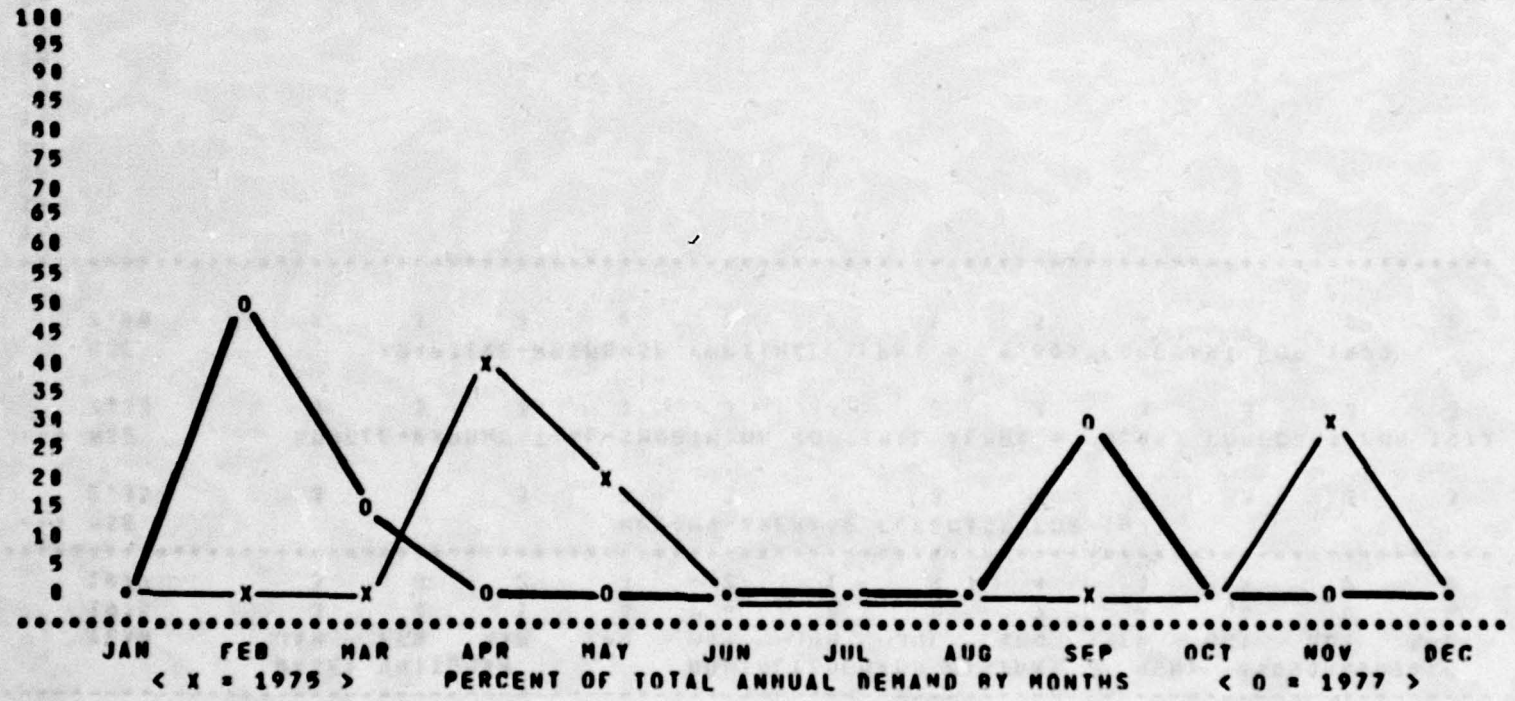
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008896653

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	4	0	0	0	0	0	6	0
1977	0	3	1	0	0	0	0	0	2	0	0	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.50	2	2	2	2	1	1	1	1	1	1	1	1

MSE	DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALPHA = 0.05) FORECAST FOR 1977											
1.17	0	0	0	0	0	0	0	0	0	0	0	0

MSE	ADAPTIVE-RESPONSE (OPTIMAL ALPHA = 0.25) FORECAST FOR 1977											
1.08	2	0	0	1	1	0	0	0	0	0	1	0



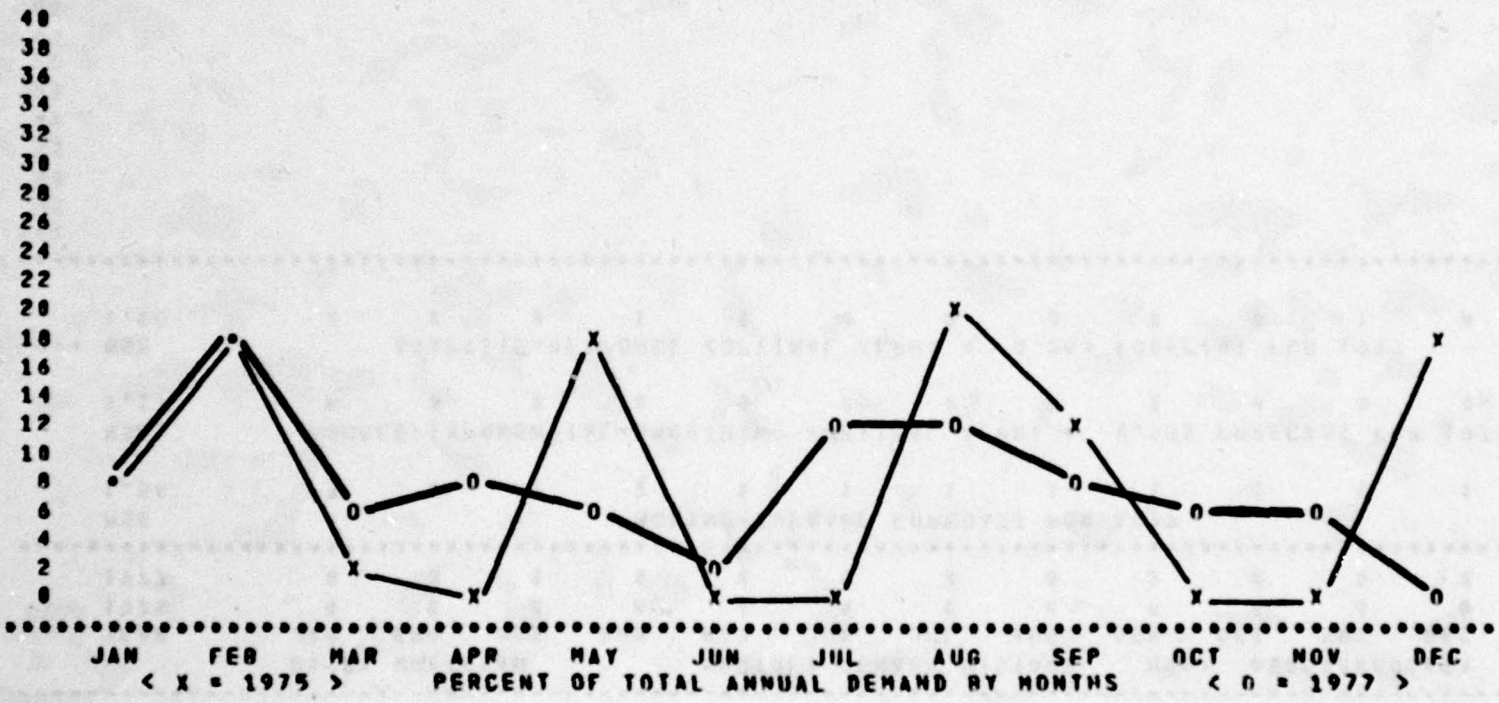
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505008902015

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	6	1	0	6	0	0	7	4	0	0	6
1977	3	6	2	3	2	1	4	4	3	2	2	0

MSE	MOVING-AVERAGE FORECAST FOR 1977											
2.33	3	3	3	3	3	3	3	3	3	3	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
2.33	3	3	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
2.58	5	3	3	2	2	2	1	3	3	3	2	2



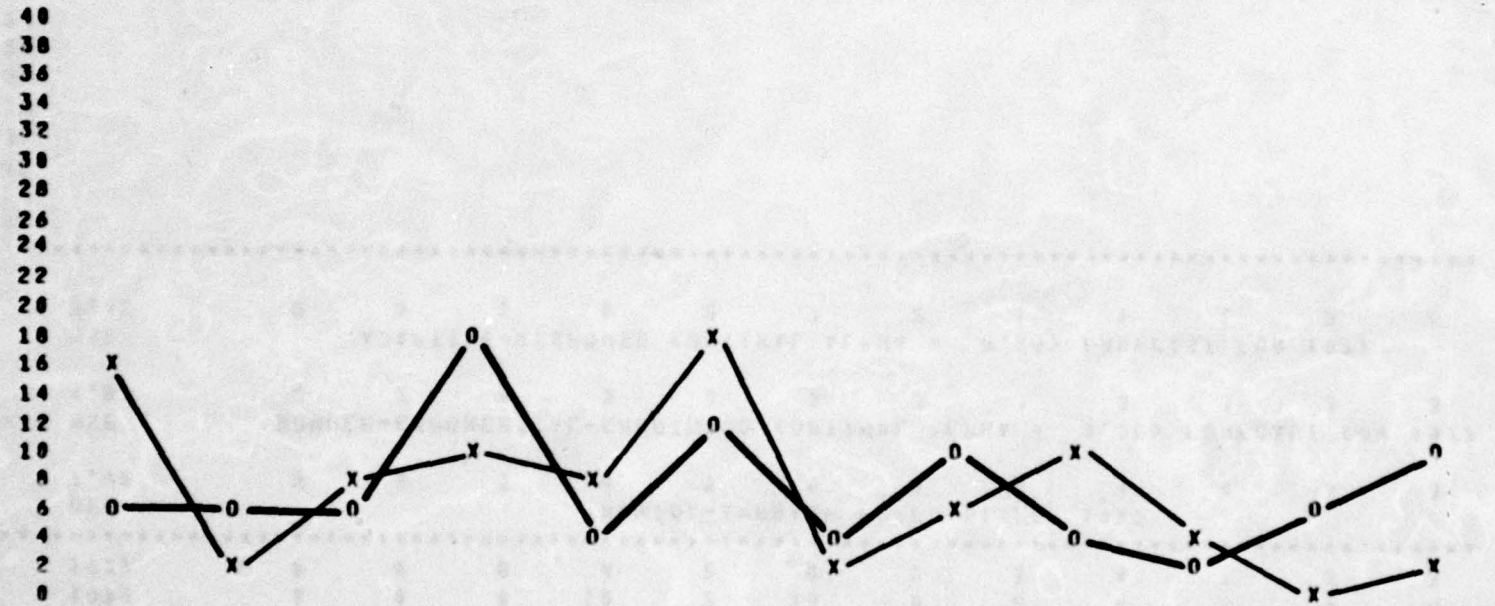
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009262895

YEAR	JAN	FEB	MAR	APP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	100	36	96	120	84	204	24	72	120	60	0	36
1977	36	30	36	84	24	60	24	48	24	12	36	48

MSE	MOVING-AVERAGE FORECAST FOR 1977											
821.25	86	74	74	69	66	61	49	49	47	39	35	30

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977											
453.17	51	44	39	37	48	45	48	43	43	38	30	30

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977											
367.75	48	37	36	30	35	54	24	35	28	29	25	24



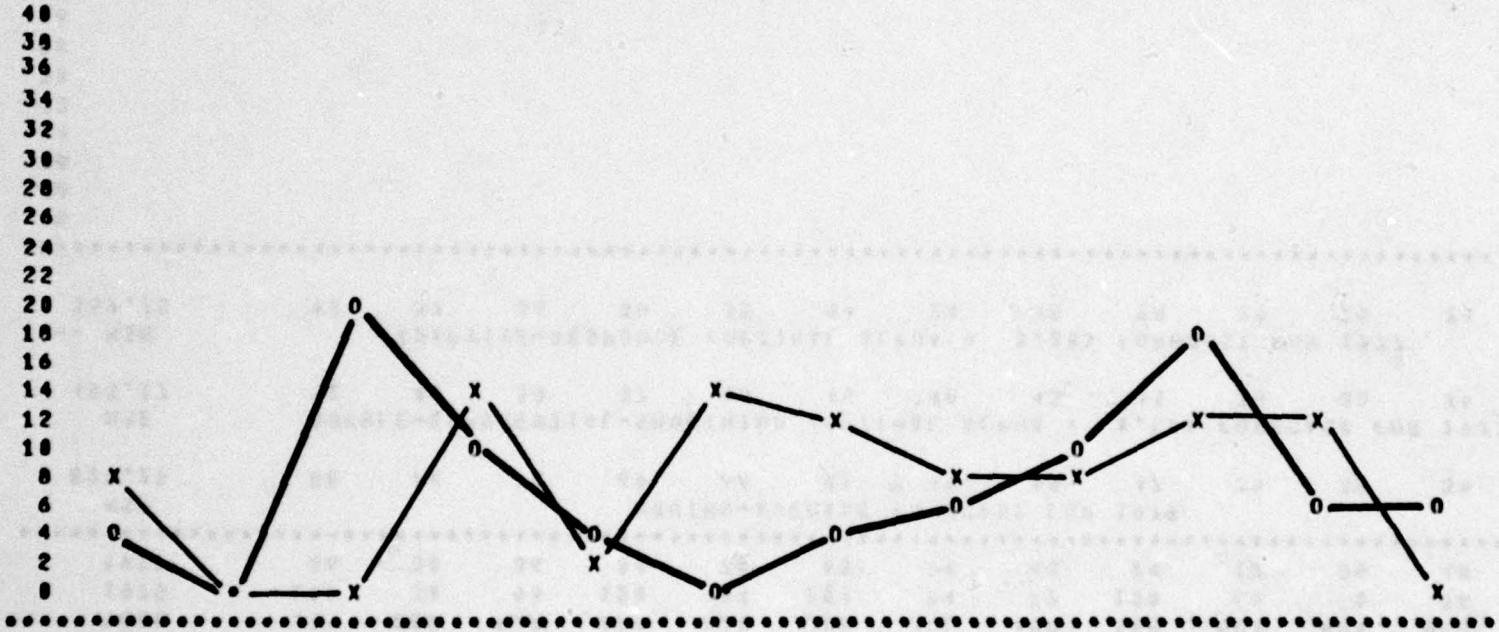
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009444130

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	0	0	10	2	10	8	6	6	8	9	0
1977	2	0	8	4	2	0	2	3	4	7	3	3

MSE	MOVING-AVERAGE FORECAST FOR 1977											
7.92	5	5	5	6	5	5	4	4	4	4	3	3

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
4.83	2	2	3	3	3	3	3	3	3	3	3	3

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
8.42	2	0	1	0	2	3	2	1	1	1	3	6



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

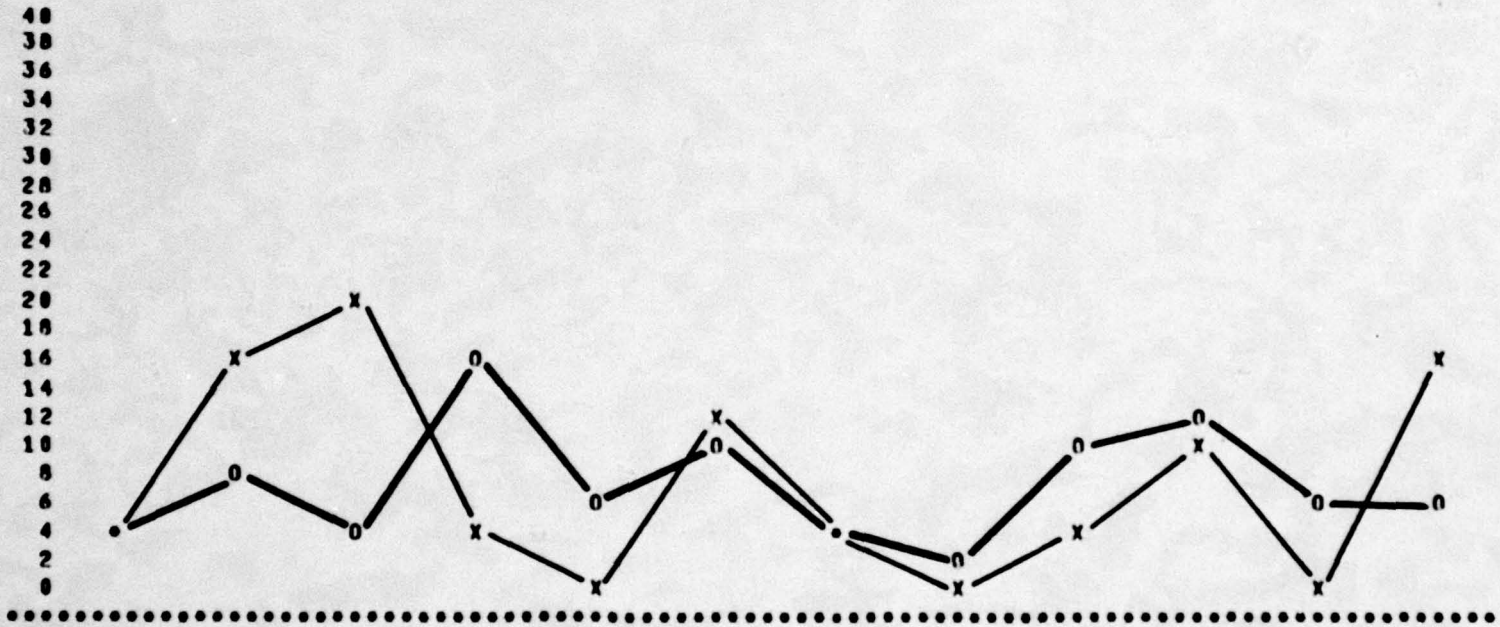
BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505009857110

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	24	72	96	24	0	60	24	0	24	48	0	72
1977	10	16	8	20	12	20	7	5	10	24	12	12

MSE				MOVING-AVERAGE FORECAST FOR 1977								
200.25	37	36	31	24	24	25	22	20	21	20	18	19

MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977											
138.17	33	30	27	22	22	20	19	16	13	13	16	15

MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977											
178.58	45	14	14	12	24	14	17	12	6	17	22	12



SELECTED BIBLIOGRAPHY

A. REFERENCES CITED

1. Ammer, Dean S. Materials Management. 3d ed. Homewood IL: Richard D. Irwin Inc., 1974.

2. _____. "Set Safety Stock to Achieve Optimum Stock-Out Policy," Hospitals J.A.H.A., XCIX (December 1975), pp. 59-61.

3. Bloss, Captain James F., USAF, Captain Michael L. Moccia, USAF, and Captain Michael J. Rowland, USAF. "A Simulation of a Medical Center Pharmacy Inventory System." Unpublished master's thesis. SLSR 5-74A, AFIT/SL, Wright-Patterson AFB OH, January 1974.

4. Brown, Robert G. Decision Rules for Inventory Management. New York: Holt, Rinehart and Winston, Inc., 1967.

5. _____. Materials Management Systems. New York: John Wiley & Sons, 1977.

6. _____. Statistical Forecasting for Inventory Control. New York: McGraw-Hill Book Company, 1959.

7. Casto, Major Graden J., USAF. Chief, Materiel Management and Procedures, Headquarters United States Air Force Surgeon General's Office, Brooks AFB TX. Telephone interview. January 1979.

8. Ferguson, Captain Richard W., USAF. "An Analysis of the Effects of Multiple Parameter Changes in the MMMS for the Computation of Inventory System Variables." Unpublished research, Air Force Medical Materiel Field Office, Frederick MD, 1977.

9. Hoffman, Raymond A. Inventories. 2d ed. New York: The Ronald Press Company, 1970.

10. Lewis, Colin C. Scientific Inventory Control. New York: American Elsevier Publishing Co., 1970.

11. Mayer, Raymond R. "The Interrelationship Between Lot Size and Safety Stocks in Inventory Control," The Journal of Industrial Engineering, July-August 1965, pp. 268-74.

12. "Medical Stock Status Report." Wright-Patterson AFB Medical Center. 31 December 1978.

13. Nahmias, Steven. "Optimal Ordering Policies for Perishable Inventories," Operations Research, XXIII, No. 27 (July-August 1975), p. 735.

14. Peacock, Captain Steven S., USAF, and Captain Michael R. Seale, USAF. "A Simulation Study of the Effects of Applying Variable Safety Levels in a Medical Inventory System." Unpublished master's thesis. SLSR 15-75A, AFIT/SL, Wright-Patterson AFB OH, January 1975. ADA006343.

15. Prior, Larry. Systems Analyst, Air Force Data Systems Design Center, Gunter AFS AL. Telephone interview and correspondence. October 1978 through February 1979.

16. Sullivan, William G., and W. Wayne Claycombe. Fundamentals of Forecasting. Reston VA: Reston Publishing Company Inc., 1977.

17. Trigg, D.W., and A.G. Leach. "Exponential Smoothing with an Adaptive Response Rate," Operational Research Quarterly, XVIII, No. 1 (March 1967), pp. 53-59.

18. Turban, Efraim, and Jack R. Meredith. Fundamentals of Management Science. Dallas: Business Publications, Inc., 1977.

19. Turban, Efraim, and N. Paul Loomba. Readings in Management Science. Dallas: Business Publications, Inc., 1976.

20. U.S. Army Combat Developments Command. Medical Service. . .75. Washington: Government Printing Office, 1969.

21. U.S. Department of the Air Force. Air Force Medical Materiel Management System -- General. AFM 67-1, Vol. V. Washington: Government Printing Office, 1977.

22. _____. Medical Materiel Management System (B-3500). AFM 167-240. Washington: Government Printing Office, 1974.

23. Van Cleave, Captain Larry B. Medical Materiel Staff Officer, Air Force Medical Materiel Field Office, Frederick MD. Telephone interview. January 1979.

24. Williams, William. Chief, Medical-Dental Division, Stock Fund Management Branch, Air Force Medical Materiel Field Office, Frederick MD. Telephone interview. January 1979.

25. Winters, Peter R. "Forecasting Sales By Exponentially Weighted Moving Averages," Management Science, VI (April 1960), pp. 324-42.

26. Zambo, Leslie J. Assistant Professor of Quantitative Methods, Air Force Institute of Technology, School of Systems and Logistics, Wright-Patterson AFB OH. Personal interview. August 1979.

B. RELATED SOURCES

Arrow, Kenneth J. Studies In The Mathematical Theory of Inventory and Production. Stanford CA: Stanford University Press, 1958.

Benton, William K. Forecasting for Management. Reading MA: Addison-Wesley Publishing Co., 1972.

Brown, Robert G. Statistical Forecasting for Inventory Control. New York: McGraw-Hill Book Co., 1959.

Buffa, Elwood S. Production-Inventory Systems. Homewood IL: Richard D. Irwin, Inc., 1968.

Diller, Stanley. The Seasonal Variation of Interest Rates. New York: National Bureau of Economic Research, Inc., 1969.

Enrick, Norbert L. Inventory Management. San Francisco: Chandler Publishing Co., 1968.

Fairhurst, George F. "Hospital Logistics," Journal of the Society of Logistics Engineers, XII, No. 12 (Summer 1978), pp. 5-11.

Fetter, Robert B., and Winston C. Dalleck. Decision Models for Inventory Management. Homewood IL: Richard D. Irwin, Inc., 1961.

Fries, Brant E. "Optimal Ordering Policy for Perishable Commodity with Fixed Lifetime," Operations Research, XXIII, No. 1 (January-February 1975), p. 46.

Fuchs, Jerome H. Computerized Inventory Control Systems. Englewood Cliffs NJ: Prentice-Hall, Inc., 1978.

Gilchrist, Warren. Statistical Forecasting. New York: John Wiley & Sons, Inc., 1976.

Hobbs, John A. Control Over Inventory and Production. New York: McGraw-Hill Book Company, 1973.

Johnson, Lynwood A., and Douglass C. Montgomery. Operations Research in Production Planning, Scheduling, and Inventory Control. New York: John Wiley & Sons, Inc., 1974.

Lee, Lamar, Jr., and Donald W. Dobler. Purchasing and Materiels Management. New York: McGraw-Hill Book Company, 1977.

Mack, Ruth P. Information, Expectations, and Inventory Fluctuations. New York: National Bureau of Economic Research, Inc., 1967.

Prichard, James W., and Robert H. Eagle. Modern Inventory Management. New York: John Wiley & Sons, Inc., 1965.

Reisman, Arnold. Industrial Inventory Control. New York: Gordon and Breach, 1972.

Stockton, R. Stansbury. Basic Inventory Systems: Concepts and Analysis. Boston: Allyn and Bacon, Inc., 1965.

Wonnacott, Thomas H., and Ronald J. Wonnacott. Introduction Statistics for Business and Economics. 2d ed. Santa Barbara: John Wiley & Sons, Inc., 1977.